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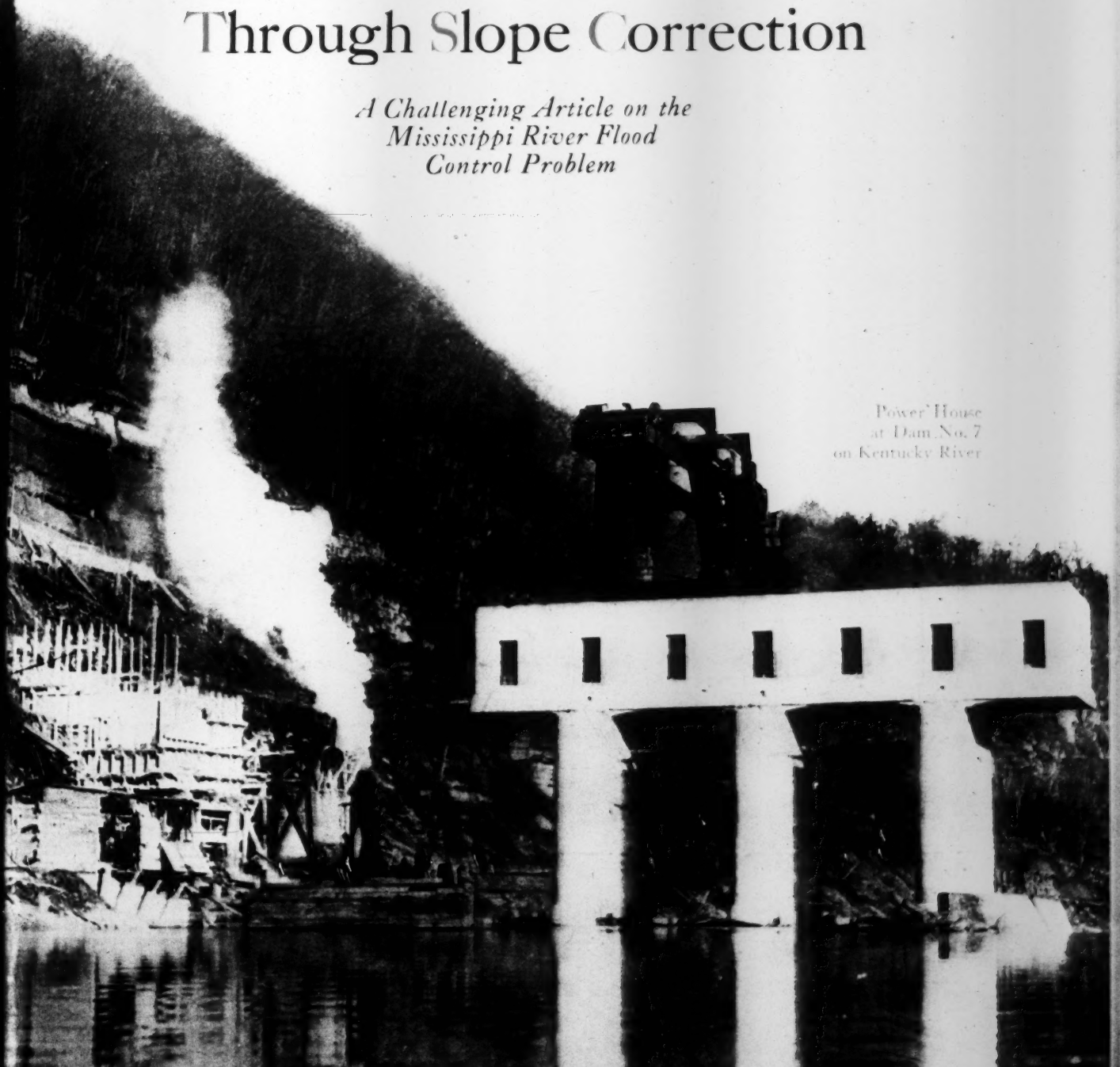
June 28, 1928

Engineering News-Record

Flood Control Through Slope Correction

A Challenging Article on the Mississippi River Flood Control Problem



Power House at Dam No. 7 on Kentucky River

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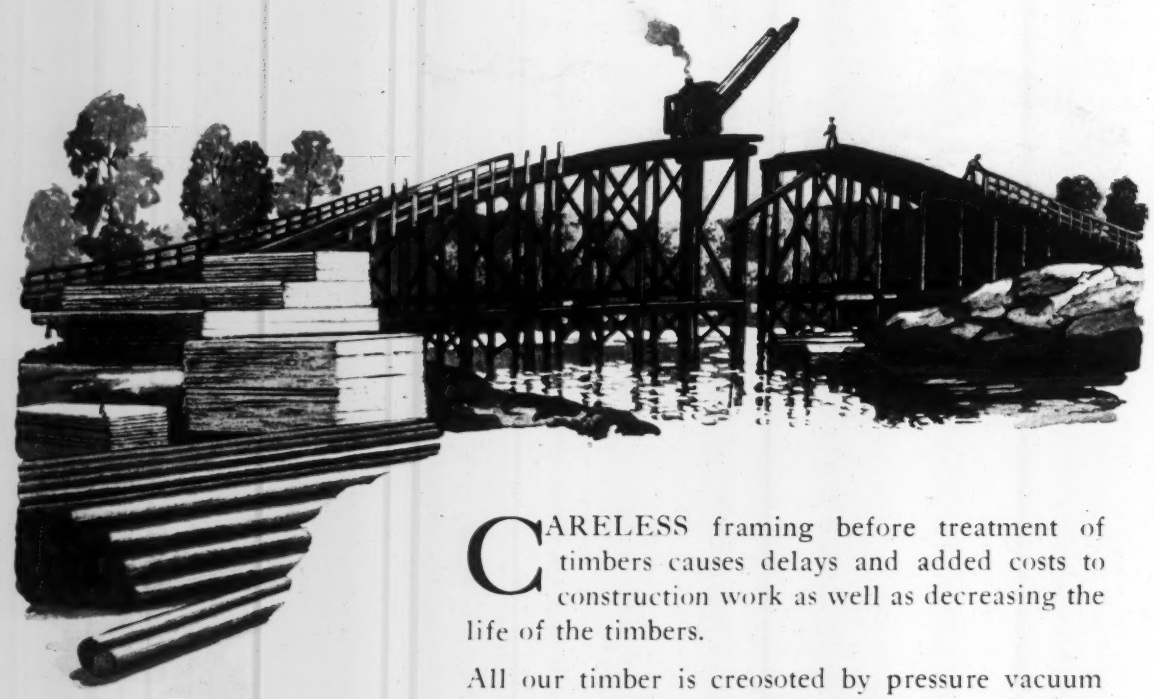

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WILLARD CHEVALIER
General Manager
F. E. SCHMITT
Managing Editor

Volume 100 NEW YORK, JUNE 28, 1928 Number 26

A Trial Balance

WITH the first half of the year drawing to a close, its performance may tentatively be balanced against the outlook presented at the beginning of January. At home there has been well-maintained stability; productive activities remain high and in some departments pass all records, among others in building and engineering construction. The generally satisfactory nature of the distribution of production, reflected in balance of supply and demand, also maintained itself well. Though political developments as represented by federal legislative work were not particularly constructive, they had no noticeable influence on the pulse of business; and quite in accord with the forecasts of discerning observers the presidential campaign produced no disturbing effects. It is particularly impressive that both production and credit kept an even tone throughout as wild a speculation in securities as we have experienced for many years. Foreign developments were neutral, being neither decidedly favorable nor decidedly unfavorable to stability and peace. American participation in world affairs became greater, chiefly in the matter of financial involvements through loans, and this may be either good or bad. It is constructive that the French currency will go to a gold basis, as appears to be in process of accomplishment at the moment. Other foreign economic developments that have occurred are slight or neutral, while political changes were by no means solely in the direction of quiet and reconstruction; however, these are not of great concern, except that the approaching end of civil war in China may turn out to be profoundly important to the world's progress. The general showing, then, is distinctly better than could be anticipated six months ago, and the signs continue to point toward a good future.

Public-Land Roads

THE veto of the public-land road bill by President Coolidge puts the Far West states that would have been chiefly benefited by this legislation to the necessity of preparing for their campaign in the next Congress. There is justice in this provision for special federal aid to roads which gives it particular appeal even to those who subscribe only indifferently to the other federal-aid policies and practices as they have been developed for a dozen years. Some eleven Western states have from 5 per cent to 90 per cent of their area held by the national government as public lands or reservations of various sorts. Under present laws the states must pay for roads through these lands on the same basis as they pay for roads in the areas over which the commonwealth has full jurisdiction and taxing power. There is an obvious lack of equity in this situation, especially in those states where the federal land holdings are large and the resources of the state itself are limited. To correct the injustice Congress made an appropriation of $10,000,000 to be spent in three years. The President returned the bill with a veto. The Senate then repassed the bill over the veto, but the House voted to sustain the veto. This, then, is the present situation. It seems only fair that the bill should have further consideration. There is no claim that in spending this money the federal interests were not fully protected. Nor does the legislation violate the principle of the present federal-aid policy that the state must undertake at least an equal share of the construction cost and shall bind itself to adequate maintenance for the future. And, finally, public interest will be served by throwing open through-state routes long before the states working with only the present federal-aid appropriations can hope to provide them.

Fair Dealing

AN APPRECIATION of what constitutes fair dealing is always a desirable attribute. It is a practical necessity when we view the civil engineering-construction industry with an eye toward its future. The paragraphs appearing in this journal from time to time under the heading "Some Recent Points Decided in Engineering Law" are published in the interests of the development of such an appreciation. Probably few of the court rulings cited can be used by the reader to his practical advantage in court. But he cannot reflect on these decisions, chosen at random from legal reports, without obtaining a clearer understanding of what real equity is. At a time when rumors are rife questioning the integrity of legal procedure, it is encouraging to read these accounts of common-sense handling of disputes. Cases in equity, which characterize the majority of those involving the contractor and the engineer, are still settled on a basis of proper justice to all concerned, even though what legal terminology knows as law cases have become so entangled with technicalities that wrong and right often appear to be synonymous. If common-sense handling of disputes by the courts will provide justice in the end, there is strong reason to suppose an equal application of common sense by the parties concerned will keep the dispute out of court. If relationships are based on an appreciation of what is equitable, fair dealing is certain to result. Fortunately, we can improve our understanding of what constitutes equity by periodically reflecting on current court decisions.

Construction Safety Again

THE disregard of safety principles displayed by builders in their common practice of hoisting building materials over city streets was spoken of in this column a few weeks ago. An equally constant and perhaps more weighty source of danger to the public is due to negligence in carrying on excavation for building foundations. Almost universally, excavated material is loaded into trucks by skips. This operation is not unsafe in itself,

but it becomes highly hazardous when it extends to loading heaped-up skips into trucks at the curb line or on the sidewalk while unrestricted pedestrian and street traffic weaves in and out. It is but a matter of time before serious accidents resulting from these reckless practices will multiply, and they will then be followed by a public outcry that may easily lead to harmful restrictions upon the building industry imposed by outside and therefore not friendly authorities. It is time for this industry, which is capable of solving intricate problems and surmounting seemingly impossible obstacles in construction routine, to give more attention to the safety of the public. Better that reform be voluntary than enforced.

Saner Waltonians

SANITY seems to have returned to the members of the Isaak Walton League, if we may judge from resolutions passed at their recent Omaha convention. Time was when every stream in their eyes was to be restored at once to its pristine purity and industries providing year-round work for a multitude of men and women were to be shut down so that fish might be available for vacation periods. But the latest resolutions of the League recognizes industry as essential. It is true that industrial wastes are described as a serious difficulty, but recognition is given to the possibility of scientific development of treatment methods which will avoid objectionable pollution. Co-operation with industry and existing agencies for a harmonious, aggressive, sustained program of stream clean-up is recommended. To this end a director of pollution control to guide and advise chapters is to be employed if finances permit. Further, the League recognizes that valuable scientific work on sewage disposal has been "sponsored, developed and carried on" by such national societies as the American Society of Civil Engineers, American Public Health Association, American Water Works Association and the Conference of State Sanitary Engineers. The League commends the activities of these organizations and pledges its support and co-operation. For this the societies should be most appreciative, for undoubtedly this mention is the first time their existence and work have been brought to the attention of the great majority of League members. The seriousness of the job placed on the societies named in living up to their reputation should be recognized.

New Ports or Canals

THE impending opening of Lake Ontario to deep-draft lake vessels by the completion of the new Welland Canal is almost certain to result in a change in traffic routes between the Great Lakes and the Atlantic seaboard. Two possibilities present themselves. Either enlarged ports for interchange between water and rail will be established on Lake Ontario, or the St. Lawrence or the Great Lakes-Hudson ship canal will be built. At the present time, it looks as if the former expedient would be adopted. Neither of the canals appears to have any prospect of being built for many years to come; the St. Lawrence because of national and international complications involved, and the Great Lakes-Hudson canal because of the physical and operating difficulties which make it of such doubtful economic value that it is sure to meet with much opposition. Under such circumstances the alternative of improving existing ports for the expeditious transshipment of freight from lake boats to railroad cars is likely to be adopted on both sides of the international boundary. Already the Canadian government has determined to make a new port at Prescott, Ont., a town well down along the St. Lawrence, below the eastern end of Lake Ontario. On this side of the line, where selection of the port is not a governmental matter, Oswego, N. Y., is setting its cap for much of the freight which now goes through Buffalo. Until the Welland Canal is opened and some sort of port facilities are available at the lower end of Lake Ontario, no one can tell how many steamship lines on the Great Lakes will extend their lines into Lake Ontario. If many do use the canal and ports of considerable size are built up on Lake Ontario, prospects for construction of either of the canals to the Atlantic seaboard will be lessened considerably.

Long-Time Defect Guarantees

DEFECT guarantees have long been common in engineering construction. As applied to complete structures, the outstanding examples are street paving and building construction. Many cities in their paving contracts still call for a guarantee against defective materials and workmanship for specified terms of years. Recently this practice has declined in favor; paving engineers more and more are preferring to depend on rigid plans and specifications and on close inspection rather than on a defect guarantee to ensure the integrity of their street surfacing.

In building practice time has brought a similar recession. The American Institute of Architects' standard contract requires a guarantee of one year on the complete building, but formerly the period was two years. In general it may be stated that in building construction a year's defect guarantee covers the whole building and that special materials and installations, as roofing and waterproofing, are guaranteed for longer periods, five to twenty years. In these longer-time special guarantees it is to be noted, however, that the work is done actually or virtually under the plans, specifications and direction of the guarantor. In case of the complete building guarantee and the common pavement guarantee the work is specified and directed by others than the guarantor.

These facts are brought to mind by the announcement of a large building contracting organization that hereafter it will give a five-year defect guarantee on complete buildings. This guarantee is premised on the requirement that the guarantor undertakes layout, design, selection of materials and construction, or that the plans if drafted outside are "approved for guarantee" by the guarantor. In substance he becomes the designing and supervising engineer as well as the builder. He puts himself outside the plain constructor class. There can be no quarrel with him for doing so, but the fact should be understood.

The long-time defect guarantee is interesting and significant as indicating the confidence of construction in its skill and sureness. But does it commend itself as advancing construction practice? More and more the thought is growing that contracting for its best interests should be divorced completely from responsibility for integrity of structure as long as the builder does not deviate from contract and specifications. A long-time defect guarantee is an uncertain agreement to administer, as has been found in paving practice. Ordinary wear and tear has to be appraised and discounted, and after several years the line between it and true defects is hard enough for the expert to determine and is seldom reasonably clear

to the layman; litigation or dissatisfaction is invariably the result. True defects in materials and workmanship are apt to disclose themselves in a year or two, and in this time wear and tear will not have advanced far enough to complicate their determination.

Without going further into the complexities of the practical administration of long-time defect guarantees it is plain that they exist. As the life of the defect guarantee is increased, such commitments shade into general-repair guarantees and thence into maintenance and upholding contracts. These are hazardous appendages to the contracting business. They call for a different set-up than now prevails in organizations for straightforward construction.

Success in Public-Works Construction

DEDICATION of the Arthur Kill bridges last week brought near completion a project of more than usual importance. But outranking the importance of the bridges themselves is the sensational fact that, although built by a governmental body, they were completed nearly six months ahead of schedule and at a saving of at least a million dollars over the estimated cost. Thus the undertaking stands as a clear-cut refutation of the charge so often made, and but too often deserved, that estimates on public-works projects mean little. Moreover, the achievement was made by straightforward plans and methods and not by herculean efforts to set up a record.

How were the results accomplished? Keen competition among a large number of bidders assured a contract price well in line with the engineers' estimate. The set time limit of fifteen to seventeen months allowed, as every estimate must, for bad weather conditions; but an open winter permitted the substructure concreting to go forward so rapidly that each substructure contractor received 100 days' bonus and the steel erection could be begun in December instead of in June. If luck thus played a part in shortening the working time, the saving in cost must be attributed to careful study of the problem on the part of the engineers, leading to designs that facilitated and cheapened the construction job. The Port of New York Authority, the engineers and the contractors deserve high commendation for their work.

Equal distinction attaches to these bridges in another respect: They are highway toll structures, and as such represent the largest toll projects yet built by public money. In March, 1926, the Port Authority secured funds for the start of construction by the sale of $14,000,000 of 4¼ per cent bonds—similar securities were later issued for the great Hudson River suspension bridge and the Kill van Kull steel-arch crossing. These bonds are in all respects public obligations, but they are secured by liens on the earnings of the bridges, not by the general credit of the state. When the earnings have retired the bonds, the bridges will revert to the two states (New York and New Jersey) as free crossings. These bridges have the distinction of being the first completed works under a scheme of financing which promises to find favor sooner or later in many parts of the country where much needed public works have long been postponed because of the strain they would place on the public treasury.

Locally the significance of the Arthur Kill bridges rests in the fact that they form the first connecting link between Staten Island, an isolated borough of New York City, and the mainland of New Jersey. Intense industrial and residential development, which has lagged behind all other sections of the metropolitan area, is brought much nearer by the connection. Because of the rapid and economical construction, because they are a successful experiment in public-works financing, and because they form a precedent for other large public toll structures, the bridges over Arthur Kill are notable.

Better Credit Practices Sought

DISSATISFACTION with construction equipment sales practices is being actively voiced by contractors. Credit methods in particular are assailed. These, it is claimed, are inducting into the contracting business an amount of irresponsible competition which is threatening the existence of the responsible majority in the business. A summons for conference and reform is going out to other units of the construction industry. It deserves a hearing.

The assertion is that lack of credit standards prevails in the equipment market, that there is gambling in credit risks, and that good credit customers are afforded no preferential conditions but instead are taxed to meet the losses from gambling with hazardous extension of credit to long-term and small-down-payment buyers. The equipment manufacturer is not branded as the only sinner. Materials producers are said to be fully as bad in their disregard of sound credit merchandising. The contractor himself is not excepted from venality in buying practices.

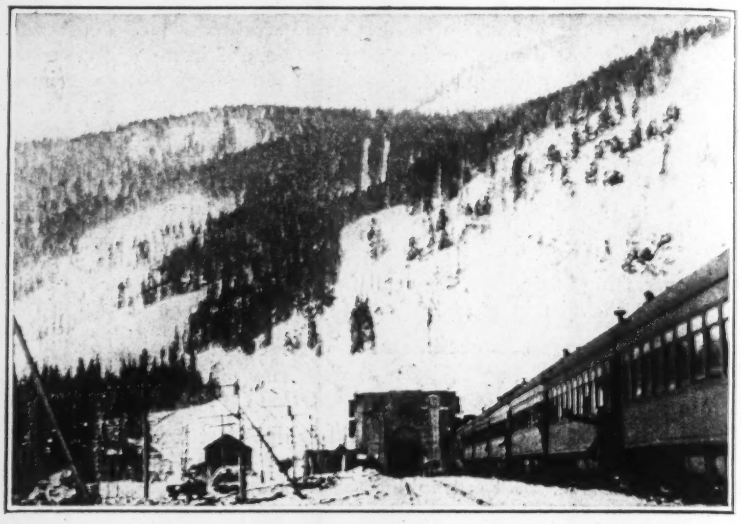
In defense the manufacturers and producers urge that the construction business requires easy credits and has been built up on this practice, that contractors themselves insist on buying on time and that those most able to pay are the most insistent on long credit extensions, and finally that the building up of new firms by special credit arrangement is a common and a legitimate means of extending their markets.

The rights in detail of the arguments are too obscure to be identified offhand. The important facts are: first, that action is being inaugurated to determine the truth; and second, that until it is determined and an arrangement is reached on credit commitments which hold to sound business practice, the contracting business will not be on a stable basis, nor will the construction materials and equipment businesses be free of the bad-debt and the repossession troubles of which they so widely complain. In this situation the contractors are taking the initiative.

In the building-construction division of the Associated General Contractors, there has been organized an allied construction industries committee, representing general contractors and twelve of the contracting trade associations. Simultaneously, the engineering-construction division has ordered its manager to concentrate on credit conferences and negotiations. By these two actions a concerted effort will be begun to stabilize credit practices—not merely those of the venders of equipment and materials but those of the contracting business itself. There is in these actions a recognition of mutual responsibility for present faults and of mutual duty to correct them. This attitude of mind is hopeful.

If the equipment manufacturers and the materials producers will display equal good will in conference on the credit problem, a long stride will have been made toward its solution. There is strong indication that they will be ready to play their parts. Meanwhile organized contracting is to be commended for having set its hand to a task that all elements of the construction industry agree must be performed.

Moffat Tunnel Ventilation for Steam Locomotives



Train Entering Moffat Tunnel

EFFECTIVE ventilation of a tunnel 6 miles long, for trains hauled by steam locomotives, was one of the operating problems involved in putting into service the Moffat Tunnel on the Denver & Salt Lake Railway. To secure such ventilation there has been installed a plant that provides induced draft and forced draft for westbound and eastbound traffic respectively. In both cases the current is in the opposite direction to the movement of the train. The experimental study for the ventilation of this tunnel was described in *Engineering News-Record* of Dec. 15, 1927, pp. 947 and 956.

The ventilating plant is housed in a concrete structure forming the east portal, as shown in Fig. 1. Each wing of the structure contains a fan chamber, while at the middle is a gate chamber for a vertically lifting gate or door which closes the tunnel when either fan is working. Only one fan is used in service, the other being held in reserve as a stand-by unit. While the fans are of different types for experimental purposes, both are about 9 ft. in diameter and 6 ft. wide. One has a 750-hp. motor and the other a 500-hp. motor, giving capacities of 450,000 and 350,000 cu.ft. per minute, respectively, with corresponding velocities of 14 and 10 m.p.h. for the air current through the tunnel. The layout of the ventilating plant is shown in Fig. 2, while Fig. 3 shows diagrammatically the operation for both directions of train movements.

Conduits or air ducts lead from the fan chambers and connect with the tunnel about 140 ft. beyond the portal. Each conduit has an air-inlet tower and a smoke-discharge tower, but with eastbound trains the smoke is blown out through the west portal. Below each tower is a hinged gate or damper to close or open the conduit. These gates, 16x24 ft., are operated in about 30 seconds, each having a 3-hp. motor geared to an operating pinion, which engages a curved rack on the gate frame. The construction is similar to a Tainter gate, but it is the flat side and not the curved end that forms the closure in this case. On account of severe conditions of snow and wind, the openings in these towers are fitted with steel louvers, which are opened or closed automatically as the dampers are opened or closed. The portal door for closing the tunnel has a steel frame 16x18 ft. covered with canvas, and is operated either by hand gear or by a motor which is controlled by a track circuit, so that the door is opened automatically on the approach of a train.

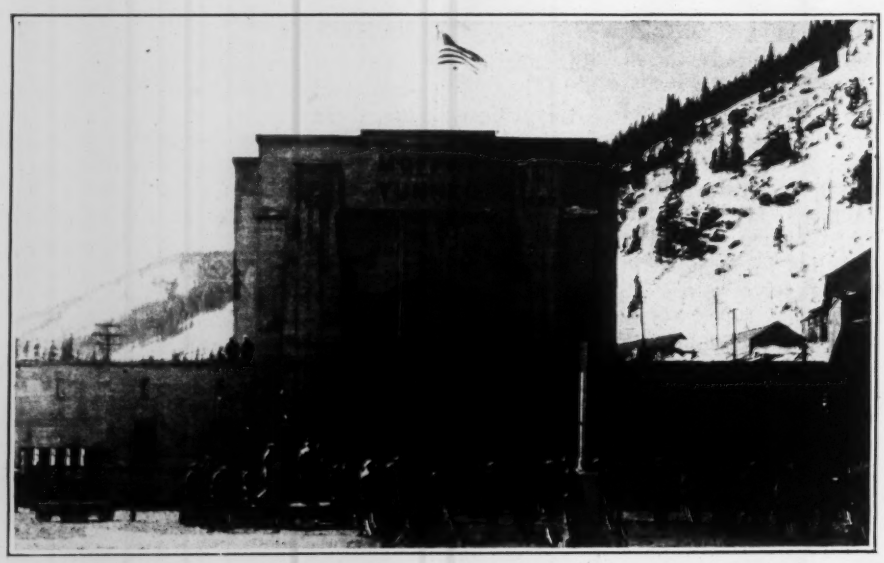


FIG. 1—EAST PORTAL AND FAN HOUSE, MOFFAT TUNNEL
Each wing contains a motor-driven fan. Portcullis door closes portal when ventilating plant is working.

From Fig. 3 it will be seen that, with a westbound train in the tunnel and the portal closed behind it, the fan creates an induced draft eastward, with fresh air entering at the west portal. One damper closes the air inlet tower, while the other opens the passage from the fan chamber to the discharge tower. With an eastbound train in the tunnel and the east

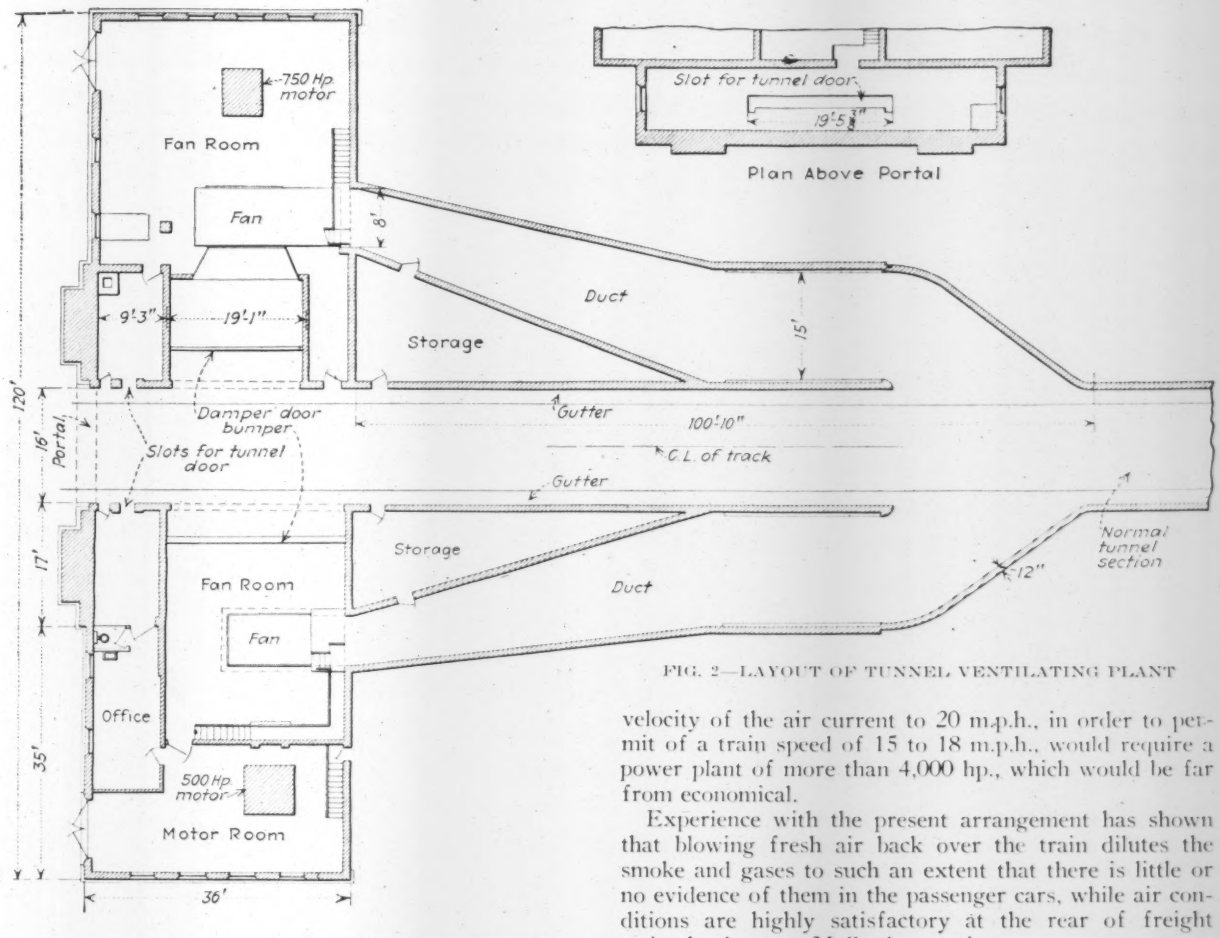


FIG. 2—LAYOUT OF TUNNEL VENTILATING PLANT

portal again closed, the fan draws fresh air through the inlet tower and discharges it into the tunnel, through which it travels westward, carrying the smoke with it, to the west portal.

A question has been raised as to why the smoke is carried along the full length of the train instead of being drawn or blown ahead of the locomotive, so that the cars would be in practically clear air. With the 500-hp. fan, a draft or air current of about 10 m.p.h. is developed in the tunnel. To keep the smoke ahead of the train would necessitate limiting the train speed to less than 10 m.p.h., which is undesirable. On the other hand, to increase the velocity of the air current to 20 m.p.h., in order to permit of a train speed of 15 to 18 m.p.h., would require a power plant of more than 4,000 hp., which would be far from economical.

Experience with the present arrangement has shown that blowing fresh air back over the train dilutes the smoke and gases to such an extent that there is little or no evidence of them in the passenger cars, while air conditions are highly satisfactory at the rear of freight trains having two Mallet locomotives.

Electric operation was considered, but under present conditions of operation on this railway, which has no through connections at its western end, ventilation is much more economical than electrification. Study of the ventilation requirements and design of the ventilating plant were under the direction of R. D. Stewart, formerly chief engineer, and A. A. Matthews, chief engineer, Denver & Salt Lake Railway, with A. F. Hewitt as construction engineer and R. F. Sporis as ventilation engineer. J. G. Sullivan, formerly chief engineer of the Canadian Pacific Railway, acted as a consultant to the railroad company.

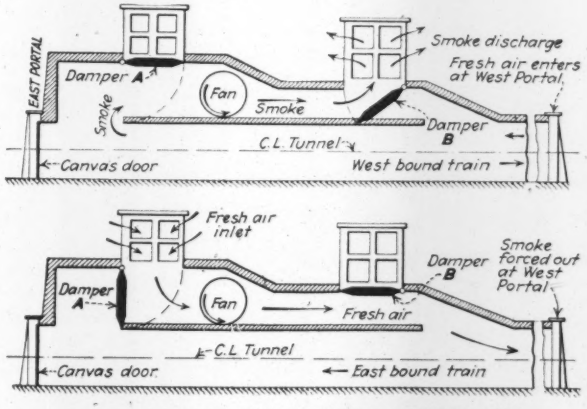


FIG. 3—OPERATION OF VENTILATING PLANT
Above, for westbound trains. Below, for eastbound trains.

Diesel Cars Pay on Branch Lines

Sir Henry Thornton, president of the Canadian National Railways, in a statement to a parliamentary committee on April 24 stated that deficits from operations on the company's branch lines had been converted into surpluses by the substitution of Diesel electric cars for steam trains. He believes that the development of the Diesel electric unit offers a solution to the problems involving service on branch lines which cannot profitably be operated by steam. Where the Canadian National has put on the electric cars losses have been turned into profits. Gross revenues on this service last year were $450,000 and expenditures were $238,000, hence there was a profit of $212,000. The company has in contemplation a larger unit, based upon experience with the present unit.

Flood Control Through Slope Correction

The Principle of Uniform Discharge Through Uniform Slope and Channel Width Applied to the Mississippi—Control May Be Attained Through Revetment, Levees, Delta Reservoirs, and Possibly Channel Shortening

By W. E. Elam
Civil Engineer, Greenville, Miss.

UNIFORMITY of flow is desirable and essential to an adequate river control. Such uniformity can be obtained by more uniform channel width and slopes. The physical means of producing these results are: (1) Revetments to starve the bar sections of deposits obtained from bends where caving takes place, thus forcing vertical rather than horizontal cutting; (2) low-water contraction and stabilization works to lower bars; (3) additional levees of greater dimensions to make the high-water channel the same length and location as the low-water channel; (4) back levees up the main tributaries in the middle reaches of the river to reduce the backwater (reservoir?) areas, which when full are now greatly widened sections of the river instead of reservoirs, and (5) possibly a reasonable number of cut-offs to straighten the channel and produce bottom cutting to lower and enlarge the channel at congested points and to equalize the slopes.

Many plans that appeal to the imagination have been offered to prevent overflows of the Mississippi River and its tributaries. Many of them disregard real facts and conditions that are not any too well understood by engineers of long experience on the river. Too hasty conclusions may prove disastrous to the people living in the Valley. Calculations made after the 1927 high water call for levees of such staggering proportions that other alternatives such as floodways, spillways, moving levees back and the usual run of after-flood suggestions have been forced into the foreground. Before these auxiliaries can be discussed much more knowledge of physical data is essential than is now available.

The data now available about slopes and channelway will be of little value for a completely regulated river. Slopes, low- and high-water channelways, certainly high- and probably low-water hydraulic channel lengths, must all be different from those of today. Complete hydraulic data of the Mississippi River would have cost nearly as much to collect as has been appropriated for actual work in many of the years since 1881. To get anything of value now the data will have to be worked up as the work is being done.

In the absence of a complete study probably too much weight has been given to those data which happened to be available, and data that would be of value in the study of a complete utilization of the present terrain between the levees north of Baton Rouge have not been obtained. It is doubtful if it can be exactly determined what this channelway can carry until real channel improvement work is under way and full-size experiments can be carried out on the river itself. Furthermore, the river bed and the land between the river banks and the levees, or hill lines, is the cheapest right-of-way. Just as much water as possible should be carried along the present channel.

In the absence of essential data, a comparison of available widths should give some idea of the possibilities. The river between levees south of Baton Rouge averages about 4,000 ft. wide (M.R.C. report of November, 1927, paragraph 207) and carried 1,461,000 sec.-ft. in 1927. But from Helena to Baton Rouge it will average at least five to six times as wide, and in 1927 it carried, at Helena, 1,410,000 sec.-ft.; at Arkansas City, 1,712,000; at Vicksburg, 1,806,000 sec.-ft. We should at least try to make this wide part carry double the discharges below Baton Rouge, or between 3,000,000 and 4,000,000 sec.-ft., and this at lower gage heights than those of the 1927 flood. To do this we must have an efficient channel.

A striking feature of the Table V of the Mississippi River Commission's report of last November is the fact that only two stations on the Mississippi River showed a maximum discharge in 1927; these were Chester, Ill. (April 27), and Carrolton, or New Orleans, (April 25). This does not indicate improvement in the carrying capacity of the channel.

Water Slopes and Channelway—The profile, Fig. 9, is compiled from data published by the Mississippi River Commission in the gage-record publication "Stages of the Mississippi River and Tributaries" and the November report. Only two low-water lines are shown. These were selected because 1895 was the record low water and that of 1917 was near it in the upper and lower reaches of the river. In the middle reaches the more recent low water was 4.7 ft. higher at Arkansas City, 5.9 ft. higher at Vicksburg and 2.9 ft. higher at Red River Landing. This may be due to differences in low-water discharges, but it may also be significant that the maximum differences occurred at the gages near the mouths of the main tributaries. It is possible that deterioration of the channelway or actual lengthening of the river between these dates may have had something to do with this result.

No conclusive data are available to show change in bar formations during the last 45 years. The M.R.C. gives a description (paragraphs 48 to 58 of the November report) which indicates that it does not see a great improvement in the channel conditions at the crossings except from removal of snags. Pilots and river men generally claim that bar and crossing conditions are distinctly *not* being permanently improved. High bars give more trouble today than they did a generation ago, and no definite general increase in depths over bars is in evidence.

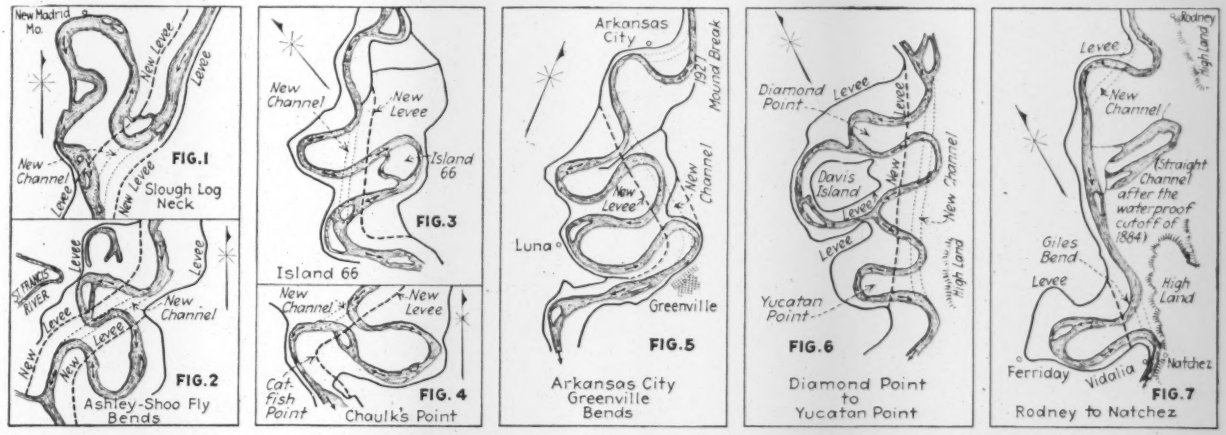
Flood Profile Characteristics—The 1925 high water occurred after three low-water years and was only about bank-full stage. This (Fig. 9) illustrates the effect of three years of low water on slopes; it should very nearly represent the slopes on which the river might be expected to build its channel if given the opportunity. This slope is much more uniform than other and higher waters. The 1926 high water was just enough higher to permit a moderate flow across points in the wide reaches of the river; it shows only a fair uniformity of slope, with some variations caused by the varying inflow of the tributaries.

The next three high waters, 1923, 1922 and 1927, show more and more irregularities in slope as the water gets higher.

The 1927 estimated water shows more irregularities than any other, indicating that the river is not building a channel to fit this kind of high water. The unprecedented discharges of the Arkansas, White, St. Francis and Yazoo rivers helped make the hump from Mhoon Landing to Vicksburg more pronounced, but this hump is shown at lower waters at Arkansas City and Greenville and should not be blamed entirely on the peculiarities of the 1927 flood. The various grade lines worked out by the M.R.C. show the same hump. It must therefore be assumed that the river is not constructing a high-water channel to carry a maximum discharge along normal slope lines.

A study of this profile shows a high-water slope along considerably in error if we undertake to apply these same slopes to a river that is completely revetted, where no water is permitted to flow in and out of the channel and across necks to disturb the channel slopes. The high-water slopes in an improved channel should be flatter than in the present channel, lowering the high-water plane in the middle and upper reaches of the river.

Revetment—Revetment is generally accepted as the bulwark of flood control. The M.R.C. has never had enough money or equipment to revet completely one bend in one season with the possible exception of one, and in that case the river cut across the point opposite the revetment, making the study of the effect worthless. However, the cutoff stopped the caving, even in the new channel, a mile and more away from the revetment, about 6 miles shorter than the old bend. This bend is said to have been the worst-caving bend on the Mississippi



FIGS. 1 TO 7—SOME OF THE TWELVE MAIN REACHES OF THE MISSISSIPPI PROPOSED FOR STUDY OF EFFECT OF STRAIGHTENING AND SHORTENING RIVER CHANNEL

the lower reaches from Baton Rouge to the Gulf of about 0.2 ft. to the mile, with a channel fairly uniform and deep. There are few islands, and the banks are not caving as much as they are farther upstream. Except in a few reaches, the course is fairly direct, the levees are close to the river and the high-water length is practically the same as the low-water length.

Between Baton Rouge and Vicksburg there are no levees on the east bank, and the levees on the west bank do not follow the river bank very closely. The slope varies from 0.2 to 0.3 ft. to the mile. In this section are found more bars, islands, bends and divided channels.

Between Vicksburg and Helena the levees are 6,500 to 40,000 ft. and more apart. Here bends are most frequent and caving banks give the most trouble. Islands, bars and divided channels are most abundant. The channel distance from Helena to Vicksburg is about 295 miles, yet during high-water periods some water could flow from Helena to Vicksburg and, by cutting across necks at the bends, travel little more than 200 miles. Water flowing outside the channel across necks—and in many places in opposition to the real channel flow—upsets the uniformity of channel slope and discharge. It adds little to the carrying capacity, for discharge observations indicate that it is only a small percentage of the total discharge of the river, being shallower and (except across necks) having little velocity as compared with the deeper water in the main channel.

While river gages and present channel distances are used to calculate high-water slopes, the results may be

River up to 1910, when the cutoff occurred; the channel has been practically stable ever since.

It looks reasonable to define the minimum revetment requirement as the total miles of caving banks known to exist. This is about 750 miles from Cairo to Red River Landing. It is assumed that the channel can be fixed as it is by stopping these banks from caving, although the consequent deepening of the channel is apt to produce changes in channel flow and cause bends to cave that are now inactive. If the curvature or length of the channel is reduced, the revetment need would likewise be reduced. In any event it would be a serious mistake to undertake any plan of flood control that did not contemplate fixing the river in one position with revetment.

Coincident High- and Low-Water Channels Desirable—It is not believed that the Mississippi River can ever be fully controlled until the high-water channel is made to conform closely to the low-water channel. The river as it is now works during low water to build a channel to suit a certain length. High water changes the length and flow conditions, which forces the river to abandon the low-water channel in a measure and build a channel to suit high-water conditions. The resulting channel has different local slopes and is frequently far removed from the low-water channel site. When the water recedes, the river has to start over and try to rebuild the channel for the new conditions.

The trouble with the present channel is evident if one will get out on it during a big flood and study the stream. It is true that some of the water is moving

rapidly enough, but much of it is also moving too slowly, particularly where bends fold back close to each other and water flows across points. The water flowing across points causes slack water in the bend and deposit of material that restricts the channel area in the bend. The great series of bends between Arkansas City and Greenville may be one of the reasons why the Arkansas City gage reached such abnormal heights in recent years. The closing of Cypress Creek may have had a part in this, but flow across points and actual lengthening of the river channel as well as channel restrictions in the bends surely have had their part.

Slack water resulting from flow across points causes deposit of materials in the channelway until the channel area is reduced enough to create the critical velocity at the new slope. This tends to lift the channel area bodily and raises gages in the vicinity without increasing the discharges. The effect is difficult to see and understand, and in consequence many engineers and laymen can find other reasons to explain these rises.

When the channel length is made the same for high water as for low water, we shall have the river working on the job of building a channel that will serve both purposes. Very likely the so-called "high-water caving banks" will then to some extent disappear. The channel will be enlarged and the ability to carry a flood will be improved.

Proposed Plan—The people in the Valley realize that we must have a plan that will lower the high waters instead of one that will raise them. The element of danger with levees 15 to 20 ft. higher than those of today would be too great for people to run the risk of a disaster ten to twenty times worse than that of 1927. Such a disaster will be inevitable sooner or later if we do not get a plan that will show a definite lowering of the high-water lines. We can be certain that the channel is being lowered and enlarged only when we see the river go as much as 10 to 20 ft. below present low-water marks at low stages of the river.

What holds the flood plane where it is now? The vast amount of material caving into the river in the caving bends moves with the water to the crossing below. Here the velocity is checked by the spreading out of the thread of the stream in crossing from one side of the river to the other. This bar, reaching entirely across the river —sometimes nearly straight across and at others taking several miles to get across—acts as a submerged dam. The slope over some bars appears to be as much as 0.5 to 0.7 ft. per mile, yet the river does not scour out so deep a channel as it does in the bend sections adjacent where the slope is much flatter.

A profile of the river taken lengthwise of the channel (see Fig. 8) would show that the river does not have a uniform slope at all, but consists of pools and rapids; the caving takes place in the pool sections *where the slope is flattest*. It is the shallow water over the crossing bars that steepens the average slope. If the bars could be removed, we could lower each pool successively until we approached the average slope of about 0.2 ft. per mile. This would give a material lowering of the water plane in the middle and upper reaches, which could amount to as much as 10 to 20 ft. at the mouth of the White and Arkansas rivers and more above this point.

Revetment will stop the supply of fresh material to the bars and may cause some lowering. Bars are caused by flow conditions in the channel, though, and we can expect them to remain to some extent until the channel is contracted by low-water spurs at the crossings. When this is done, we shall eliminate some of the present drop over the bars.

If coincident channels and removal of crossing bars do not give sufficient lowering of the flood plane, further steps are available. Elimination of divided flow around islands will flatten the average slope to some extent. The gain from this would be small. It is also probable that most of these islands would of themselves join with one shore or the other when the channel is confined to one definite location under all conditions.

Erosion—In discussing any plan there are some laws of stream flow and erosion of alluvial riverbeds that should be kept in mind. The first is that the velocity of the stream depends mainly on the slope and hydraulic radius. These are about all we can influence with flood-control works. It must be understood that there is a balance somewhere between the velocity of a stream and its eroding power.

A balanced condition is reached in either of two ways. If the erosion is on the side or banks, the river lengthens

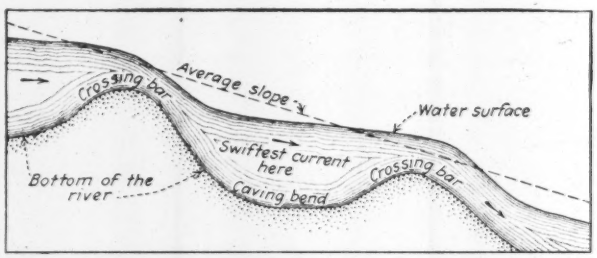


FIG. 8—SWIFTEST CURRENTS IN BENDS CAUSING CAVING WHERE SLOPES ARE FLATTEST

itself and the slope is flattened enough to stop the caving. If the erosion is on the bed or bottom of the river, the upper reaches are lowered enough to flatten the slope and stop the caving. But Nature does not always select the type of caving that best suits man's ideas; this must be the function of flood-control works, in order to get the river into a stable condition. When this is done, the elevation of the water surface at any point will depend on its distance from the mouth of the river and the critical slope of the bed of the river through the alluvial soils in the various reaches.

If we can control bank erosion and force bottom erosion, we can say what we want a river to do and then make it follow the plan. Stopping bank erosion with revetment will force bottom erosion to take place and lower the bed *if the high- and low-water channels are made coincident*, but not otherwise.

Curvature—The effect of curvature on erosion is little considered. Caving is usually more rapid in the sharper bends, and is probably due to the bank being the agency that deflects the water from a straight line and having to stand the wear of this pressure in addition to the velocity effect. If left alone, one bend would cave into another after a time and shorten the river, but this would not be a satisfactory solution of the problem of obtaining the correct length of channel. To continue preventing cutoffs while permitting caving to continue at many other places will probably ultimately produce a river that will be stable. But the indications are that the river will build a channel for high water with a large portion of its area above the general level of the land. This would occur in such series of bends as now exist between Arkansas City and Greenville.

Forcing the river to deepen and enlarge the channelway must be the ultimate solution of the problem. Present levees were never located with any idea of providing a channel to carry the water during a flood. If they had been, they would have been placed a uniform distance apart and with some definite relation to the riverbanks in order that the overbank channel would merge with and be a part of the main channel. This would have made the low- and high-water channels coincident, with consequent marked improvement of the floodway.

It should be realized that nothing can cause the Mississippi River currents permanently to exceed the present velocities. Lengthening or widening the river more than is necessary will check velocities and raise the channel area of the stream beyond a doubt.

High Water Flattens Slopes—It seems logical to assume that the levees located on the banks of the river south of Baton Rouge have contributed to the excellence of that channel and its comparative freedom from bars, islands and caving banks. However, it is not recommended that levees be placed on the very edge of the river banks, for obvious reasons.

The need of preventing flow across points should be apparent from Table I, which shows that the slope of the Mississippi River from Cairo to the Head of the Passes varies from 0.06 to 0.5 ft. to the mile even in a moderate water like that of 1925. The maximum slope in the higher waters is slightly less. The last column is significant in that it shows that higher waters flatten the slope in some reaches instead of steepening it, as one would expect. This is an indication that a proper channel length is not maintained in the higher waters and that some shortening of the channel could be obtained

TABLE I—VARIATION IN HIGH-WATER SLOPES IN THREE HIGH WATERS

	Dist. in Miles	High-Water Slopes 1925	1922	1927	1927 Est.	Range of Slopes	Change Due to Higher Water
Cairo to New Madrid	71.0	0.315	0.370	0.390	0.390	0.315–0.390	Steepens
New Madrid to Fulton	104.4	0.490	0.475	0.460	0.460	0.490–0.460	Flattens
Fulton to Mhoon Ldg.	97.8	0.410	0.425	0.435	0.435	0.410–0.435	Steepens
Mhoon Ldg. to Helena	33.9	0.500	0.340	0.285	0.285	0.500–0.285	Flattens
Helena to Arkansas City	163.5	0.330	0.310	0.320	0.270	0.330–0.270	Flattens
Arkansas City to Vicksburg	165.1	0.345	0.325	0.320	0.320	0.345–0.320	Flattens
Vicksburg to Natchez	103.9	0.300	0.275	0.300	0.275	0.300–0.275	Flattens
Natchez to Red River Landing	66.9	0.220	0.200	0.185	0.225	0.220–0.185	Flattens
Red River Landing to Baton Rouge	68.4	0.175	0.200	0.200	0.210	0.175–0.210	Steepens
Baton Rouge to New Orleans	123.5	0.125	0.190	0.210	0.205	0.125–0.210	Steepens
New Orleans to the Head of the Passes	82.3	0.060	0.140	0.170	0.190	0.060–0.190	Steepens

without altering present flow conditions materially. The flattening occurs in reaches where most flow occurs across points and indicates that the high-water channel is shorter than the low-water channel.

A Possible Improvement—Navigation has not been seriously hampered by the present-day slopes, which are steeper than are likely to be produced in an improved channel of even somewhat shorter length than the present channel. It is estimated that an improved channel would have high-water slopes varying from 0.17 to 0.425 ft. to the mile, or even less. These slopes are slightly less than present slopes and could be reasonably expected to obtain if the river is given the opportunity to build continuously on one set of channel conditions.

Table II is obtained by applying these probable slopes to the present length of channel and is intended to show what might be expected from a judicious combination of (1) revetment enough to stop caving banks; (2) dredging and low-water contraction works at the crossings to confine the water to one channel as much as possible and reduce fall between the pools; (3) levees and spur construction sufficient to make the high-water channel the same length and location as the low-water channel; (4) elimination of the backwater areas at the mouths of the tributaries so far as practicable; and (5) such cutoffs as may be needed to lower the water plane at points where sufficient lowering cannot be obtained otherwise.

TABLE II—PROPOSED SLOPES AFTER RECTIFICATION WITH GAGE READINGS BEFORE AND AFTER

Reach of River	Est. Ult. Slopes	Probable Gage Readings for 1927 H.-W. Vol.	M.R.C. Estimated Gage Readings for 1927 H.-W. Continued
Cairo to New Madrid	0.425	39.5 at Cairo	58.5
New Madrid to Fulton, Tenn	0.425	24.0 at New Madrid	46.1
Fulton to Mhoon Ldg	0.400	26.5 at Fulton	44.2
Mhoon Ldg. to Helena	0.350	35.0 to Mhoon Ldg.	49.3
Helena to Arkansas City	0.300	42.5 at Helena	59.0
Arkansas City to Vicksburg	0.280	48.5 Arkansas City	69.0
Vicksburg to Natchez	0.200	52.0 Vicksburg	62.7
Natchez to Red River Ldg.*	0.200	59.5 Natchez	63.3
Red River Ldg. to Baton Rouge	0.200	59.5 Red River Ldg.	61.5
Baton Rouge to New Orleans	0.200	49.5 Baton Rouge	50.3
New Orleans to Head of Passes	0.170	24.7 New Orleans	24.6

*Old river open as in 1927. A controlled spillway and enlarged outlet down the Atchafalaya River could make material difference in the gages below Red River Landing.

The ultimate slopes suggested in Table II are well within the range of present-day slopes and, it is believed, will not be very different from natural slopes that would result if the channel is given the opportunity to develop naturally. The present irregular range of high-water slopes, shown by Table I and the profile, Fig. 9, indicates that there is something radically wrong with the high-water discharge channel of today. This in turn has an injurious effect on the low-water channel development.

Reservoirs—Reservoirs, of a kind, are already in existance in the backwater areas at the mouths of the tributaries. These are one of the most disturbing factors of river control. More attention has been given to them as land-reclamation projects than for their effect on flood heights. The vast areas at the mouths of the St. Francis, White, Arkansas, Yazoo and Red rivers, particularly, are flooded by water taken from the channel of the river before there is any need to relieve the main channel. This abstracted water does not reduce the ultimate stages materially, if any. The water is taken from the river at the wrong time and is held to add to the burden when a levee breaks in the vicinity. It would be better for that water to go on down the river, scour out the channel to some extent and get out of the way.

If there were only one of these basins, it would not be serious; it would then have more the effect of a governor. But when several fill one after the other, a very serious situation results. When the crest of a flood reaches the upper backwater area, this area has ceased to take water from the channel and relieve the main river. In other words, it ceases its beneficial action just at the time when it is most needed, and begins to be a burden. It prolongs the crest stage at this point and begins to pour its great volume of water back into the main channel to compensate for any reduction of discharge coming from above, holding the channel below to the maximum discharge for a longer period than normal. This constitutes a piling up of water on the tail of a flood instead of relief. The river at the reservoir and below is held practically stationary, and the effect on the river below

is a flattening of the slope to reduce discharges without a corresponding reduction in gage heights. The river may show a slight tendency to rise with the discharge decreasing, which, to say the least, is not what we want. The effect of these backwater areas is cumulative and could raise gages downstream several feet above normal gage heights for the discharges.

To utilize the backwater areas advantageously and remove the present threat of their existence require that these areas be kept empty as long as possible by means of back levees up the tributaries, to reduce as much as possible the areas now flooded. If this is done, these areas would be available as reservoirs to relieve the main channel when flood discharges exceeded the capacity of the levee system. Water drawn from the channel then would be retained in the backwater area and not bypassed farther on down the river to add danger to already critical situations. It is estimated that the Yazoo Basin alone could take as much as 200,000 sec.-ft. for two weeks or more. This, taken from the top of a normal flood wave, would be of tremendous benefit and no disadvantage to the discharge below this point.

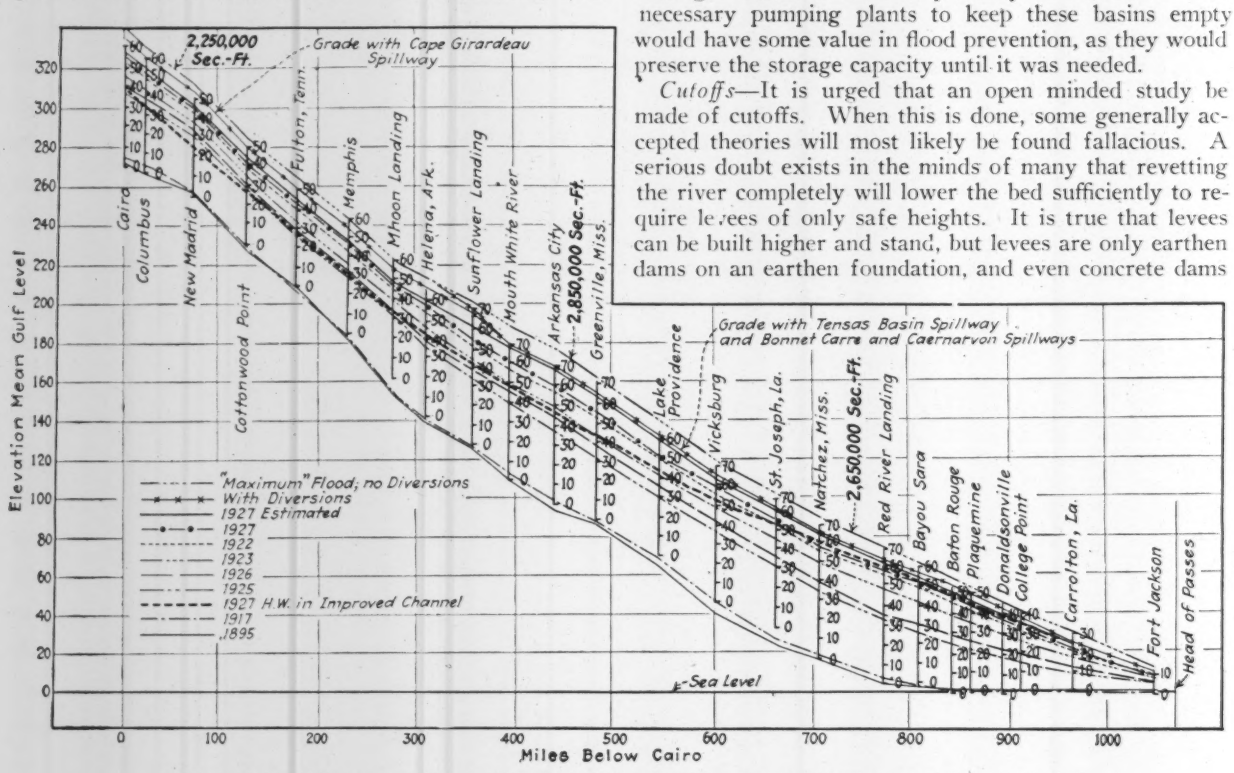


FIG. 9—HIGH-WATER PROFILES OF THE MISSISSIPPI FROM CAIRO TO THE GULF

If these backwater areas are kept empty as long as possible, nothing like the present volumes of water could go through a break near these places, because the water would not be there. On reaching the lower end of a basin the flood waters would find a real reservoir to fill and this would take a little time. The reservoir effect would delay and lower the crest instead of hurrying and raising it. When the backwater area would fill and begin to let water back into the main river, the fall due to any break above would have got down the main river and there would be no piling-up effect as occurred at Vicksburg and below in 1927.

In either event the people living in the lower ends of these basins would suffer less than they do now, even if these basins should be flooded occasionally to relieve the main channel. In case of a break their period of inundation would be materially reduced. In view of this it would be advantageous to the river and the inhabitants to cut these deltas off from the river as much as possible and construct controlled spillways into them to be of use when they are needed as reservoirs. The use of this land in this way would be entirely different from the use of land for a floodway through a basin. The land, having much more protection than it has now, would not be damaged and claims could probably be outlawed. The necessary pumping plants to keep these basins empty would have some value in flood prevention, as they would preserve the storage capacity until it was needed.

Cutoffs—It is urged that an open minded study be made of cutoffs. When this is done, some generally accepted theories will most likely be found fallacious. A serious doubt exists in the minds of many that revetting the river completely will lower the bed sufficiently to require levees of only safe heights. It is true that levees can be built higher and stand, but levees are only earthen dams on an earthen foundation, and even concrete dams on rock foundations sometimes fail, as did the St. Francis dam. The only way to reduce levees to safe heights is to compel the river to excavate its own channel at a lower level. If the proper length of river for this is once determined and established with suitable flow conditions, it will stay put. It is not necessary to eliminate the storage capacity where the levees are far apart in the reaches from Cairo to Baton Rouge. Suitable long spur layouts to make low- and high-water travel the same length should produce practically the same conditions and slope that now exist below Baton Rouge. This would still retain the storage effect to flatten flood crests on rapid rises coming down the main river and with little corresponding evils.

Where Cutoffs Are Possible—An inspection of the latest published maps of the M.R.C. indicates that realignment of the river (and levees) is possible in as many as 35 places between Cairo and the Gulf. This is much more than we need, or could use, for that matter. It is enough to know that there are ample locations well distributed along the river to influence any sections of the river that call for this kind of treatment.

Since 1881, by the prevention of natural cutoffs, the

channel length has increased some, probably from 10 to 15 miles. Just what effect this has had on the upper gages is problematical, though it must have raised them some. Whether this lengthening of the river has reduced currents is difficult to determine. Some of the present-day excessive currents could be attributed to violent changes in channel length that occur when the flood plane gets above the natural ground elevation and water flows across points, bypassing a pool on the way down the river.

The danger from an excess of cutoffs (other than bank erosion, which can be controlled) would be excessive slope in the lower reaches of the tributary streams. An acute situation can arise at these points with any lowering of the main river, even without cutoffs. It may eventually be necessary to build a combination lock and dam and controlled spillways across the Arkansas, White and Yazoo rivers. These dams could be used for power without detriment to the original purpose, contrary to the usual rule that dams cannot be used for both purposes.

It is not believed that velocity enough to handicap navigation seriously ever did or ever will persist over any considerable time from a cutoff. Isolated cutoffs (particularly one at Albemarle, Miss., in 1911 and 1912) have not set up excessive currents or caving in the immediate vicinity. Effects are often so remote from causes that they are not always connected. Observation indicates that the slope is steepened slightly above the cutoff, probably enough to increase current velocities as much as 10 per cent. This would hardly be enough to be perceptible to navigators who are accustomed to season variations in river currents, but would be enough to set points caving that were already near the critical velocity. These points would be mainly above the cutoff, and revetment is the answer.

Considerable thought, study and experiment will have to be given to cutoffs to utilize them successfully in a river-control program. A hydraulic laboratory might be used for such a study and should give some indication of what to expect, but the final test will come when the experiment is made on the river itself. In this study, surface slopes will probably be found to be the predominating influence, instead of discharges. The required discharge must follow channel changes that enlarge the discharge capacity of the channel. Some increase of velocity will have to be set up and endured to get the increased channel area and maintain it after it is obtained, but this will be mainly at points not now troubled with excessive currents. Some dredging will have to be done on heavy gravel bars, but this material will be needed for revetment. It is believed that less than 10 per cent increase in velocity, if properly utilized, will produce most of the increased channel area needed. Then discharge will be an effect and not a cause.

Registration of Engineers in Australasia

The licensing of engineers in Australia, as in this country, is a state rather than a federal matter. Although a number of attempts have been made to enact legislation in the various states requiring the examination and registration of engineers, none of the attempts has yet been successful. Many of the acts have been sponsored by the Institution of Engineers of Australia. In New Zealand a registration act is in force principally for the protection of government work. Registration of engineers is not compulsory, but the government will not advance or authorize loans for any public undertaking unless the work is supervised by a registered engineer.

Sewage Agitation and Chlorination Tests at Havre, Mont.

Reduction of Bacteria and Hydrogen Sulphide Indicate That Process Would Meet Low Stream Conditions

By Emil Sandquist and H. B. Foote
City Engineer, Havre, Mont., and Sanitary Engineer, State Board of Health, Helena, Mont., Respectively

WORKING-SCALE tests of chlorination, preceded by agitation to break up the solids, indicate that this process can be installed in the three main outlet sewers of Havre, Mont., for use during a short period of low stream flow in place of building at far greater cost an intercepting sewer to convey the sewage to one point, a pumping station and a more elaborate plant, originally proposed for year-round treatment. The events leading up to the tests, including a change in stream-flow regimen, are outlined and the tests and their results summarized in this article.

On Jan. 13, 1919, the members of the State Board of Health of Montana adopted a resolution calling upon the city of Havre to install "a sewage-treatment plant or plants of sufficient size and capacity to treat properly the sewage from the Havre municipal sewage system" so as "to deliver a sewage effluent of such composition and stability that it will not place an undue burden on water purification plants located on the Milk River below Havre." Since that date bond issues for the construction of a sewage-works by the city have failed, in 1919 due to the low market and in 1927 due to defeat at the polls.

Havre is located in the north-central part of Montana in the Milk River Valley. Below Havre and on the Milk River are the towns of Chinook and Harlem, which use the waters of the river for domestic purposes after mechanical filtration. The direct distance between Havre and Chinook is 21 miles and between Havre and Harlem, 44 miles. The stream distance is probably about twice as much. The stream velocity is calculated as 2 m.p.h.

The total amount of sewage discharged into Milk River is 0.587 m.g.d. This is delivered at the foot of First, Seventh and Fourteenth Aves. at rates of 0.122, 0.287 and 0.188 m.g.d. The estimated cost of an intercepting sewer, sewage pumping and treatment plant ranges from $80,000 to $135,000, according to whether the sewage is merely screened or given complete biological treatment.

Studies of the daily discharge of Milk River, available from 1898, indicate that during three-fourths of the year dilution will be equal to or in excess of 7 sec.-ft. per 1,000 population. During the remaining one-fourth of the year the flow has been less than this amount. Since the operation of the St. Mary's Canal, located in Glacier National Park and constructed to divert water from St. Mary's River on the Hudson Bay Divide to the upper reaches of the Milk River, the flow of Milk River has been appreciably increased during the irrigation season, principally June, July, August and September. These increased flows and those due to the spring and early summer runoff and the later fall rains usually keep the flow of Milk River in excess of 50 sec.-ft. during the nine months, which would give a dilution of more than 7 sec.-ft. per 1,000 for the 6,500 population of Havre.

The sewage from the First Ave. sewer, on which the test plant was built, is fresh, domestic sewage, having no industrial wastes other than that of the local steam laundry, considered farther on, but having a high sulphate

content. The amount of sulphate cannot be stated definitely, as the water supply of Havre is derived from two sources—groundwater sources which have relatively high sulphate contents, that from the Third St. station containing 275 p.p.m. of the sulphate radicle and that from the Park station 400 p.p.m. Laundry wastes were found to be discharged into the sewer at regular intervals. Between 9 and 10 a.m. on Monday the starch tank is thoroughly washed out, and a small amount is discharged between 3 and 4 p.m. The wash water is being continually drained during the day and the wheels empty at 5 p.m. It was found that a heavy coagulant appeared at approximately the same time that the starch solution was discharged.

The hydrogen sulphide content varies considerably during the 24 hours. The average for the "day" flow was found to be 4.10 p.p.m., while that of the "night" flow was 2.30 p.p.m. Hourly tests taken for 48 hours showed an average of 3.76 p.p.m. of hydrogen sulphide. The settleable solids, as determined in a conical flask, varied from 0.10 to 0.80 per cent, the average being 0.36 per cent. A majority of the solids had settled in fifteen minutes, but sometimes the time required for total settlement varied from five minutes to 24 hours. The average of four samples taken when a heavy coagulant appeared in the sewage showed 0.20 per cent in fifteen minutes and 5 per cent in 24 hours, indicating that the precipitate of floc was slow settling.

The essential parts of the test plant were a motor-driven 8-in. wooden propeller, extending at least 3 in. into a well dug near the 15-in. outlet sewer; liquid chlorine dosing apparatus; a 12-in. measuring weir in a manhole; and simple laboratory equipment, which, with the motor, was housed in a 6x6-ft. shack above the 4x5-ft. well. A partition with a 12x12-in. opening divided the well into two nearly equal parts, one for the propeller, the other for receiving the chlorine. The propeller was driven at about 500 r.p.m.

The chlorine dosage was varied to determine the amount required to maintain a residual of 0.50 to 1 p.p.m. (after ten minutes). The residual chlorine was determined by the ortho-tolidine method, using copper sulphate

BACTERIAL REDUCTION BEFORE AND AFTER AGITATION AND CHLORINATION

Chlorine Dosage, p.p.m.	Residual Chlorine, p.p.m.	Bacterial Content — Before Treatment — Total Per c.c.	Before Treatment — B. Coli in 1 and in 10 c.c.	After Treatment — Total Per c.c.	After Treatment — B. Coli in 1 and in 10 c.c.
15	0.50	364,000	+	1,200	—
20	1.20	218,000	+	300	—
21	1.40	192,000	+	100	—
14	0.40	480,000	+	300	—
16	0.60	258,000	+	300	—

and potassium bichromate color standards for comparisons. The dosage ranged from 10 to 21 p.p.m., varying with the amount of flow and the hydrogen sulphide content of the sewage.

The sewage solids were very satisfactorily broken up. Observation was made for a few days at the river to note whether or not a difference could be seen as to the size of solids discharged with and without agitation. This seemed to indicate desired results. Composite samples of sewage were taken before and after agitation to determine, roughly, the total amount of solids. This was done by placing 23 hourly samples of 1 gal. each in large containers. The composite samples were then poured through two-ply mosquito netting and the amounts retained were recorded as follows: Before agitation, 6.50 oz.; after agitation, 0.75 oz. Expressed in terms of suspended solids these were 0.883 per cent before and 0.102 per cent after agitation, a reduction of about 88 per cent. The percentage of settleable solids, as shown by a conical flask before and after agitation, indicated no marked difference, the general appearance after agitation being somewhat darker than the milky color before agitation.

The hydrogen sulphide content was determined by titration as outlined on p. 58 of the A.P.H.A. "Standard Methods of Water Analysis," sixth edition, 1925. The data obtained were divided into two groups: (1) all untreated samples containing 2 to 4 p.p.m. H_2S; (2) untreated samples containing 4 to 6 p.p.m. H_2S. With agitation only there was an average reduction of 26.5 per cent (from 4.08 to 3 p.p.m.). Agitation combined with chlorination gave an average of 63 per cent reduction (3.8 to 1.4 p.p.m.).

With the operation of the chlorinator and agitator, total bacterial and B. coli reductions were obtained as shown by the accompanying table.

The cost of operation for each such plant, with agitation, is approximately as follows:

	Per Month
Power, heat and light-demand charge	$2.00
Current 32.64 kw./day = 979.2/mo. @ $0.026	25.46
Liquid chlorine 500 lb./mo. @ $0.12	60.00
Water, supplies, etc.	22.54
	$110.00

For the operation of three such plants the monthly cost would be approximately $330. This would necessitate an annual expenditure of $990 for three months' operation, or $1,320 for four months' operation per year. This is only about 1 per cent of the cost of an intercepting sewer and sewage pumping and treatment plant.

Possible changes in operation consist of a stilling and settling chamber previous to agitation, an agitation chamber and a baffled mixing chamber into the entrance of which the chlorine would be introduced. Sedimentation would cut down the amount of work necessary for the agitator and give a sewage at the point of chlorine application as free as possible from large solids and hydrogen sulphide. The floating solids would be skimmed from the settling chamber and treated with a caustic for digestion and the settling solids would be removed by hand from a sump.

Bearing in mind the fact that the agitator reduces the size of suspended particles or solids and that a stilling chamber, as just described, would aid in additional removal of these solids, and also that chlorination so profoundly affects the bacterial content of the sewage, we believe that this method of sewage treatment may be a possible substitute for other methods in cases where circumstances are such that it is financially impossible to build the more expensive system.

Further study to determine the effect of the chlorinated sewage upon the diluting stream as to organic content, biological oxygen demand and those other factors which are inherently a part of the problem should be conducted to make certain the part such a method may play in the general problem of sewage disposal.

Alaska Railroad Returns First Profit

The Department of the Interior announces a profit of $5,619 in the operation of the Alaska Railroad for the month of December, 1927, the first time in its history that the road has returned a profit.

FIG. 1—ELEVATED POWER HOUSE, KENTUCKY RIVER DAM
Three wheel pits are beneath the piers, the turbine shafts passing up through the piers into the generator room. Roof of wheel pits level with crest of dam. Headgates shut off water from pit at right to permit of installing turbine.

Power House Supported on Piers Over Dam

Generator Room of Hydro-Electric Station at Dam No. 7 on Kentucky River Built on Top of High Piers in Gorge Where Spillway Could Not Be Restricted by Placing Power House at One End

AN ELEVATED power house supported on tall piers above a dam, in order to avoid shortening the spillway length, is the unusual construction adopted for the hydro-electric development at Lock and Dam No. 7 on the Kentucky River. To supplement its main power development at the Dix River dam (*Engineering News-Record*, April 2, 1925, p. 548) the Kentucky Hydro-electric Company has established an auxiliary plant to utilize the normal fall of 15 ft. at this Kentucky River dam, which is ½ mile below the month of the Dix River and 4 miles below the main power plant, creating a pool at the tailwater level of that plant.

Of the fourteen dams and locks for slackwater navigation on the Kentucky River, No. 7 has the shortest dam, with a spillway length of only 340 ft. As a maximum flood stage has been known to give 27 ft. of water on the spillway, with no fall, it was considered to be highly undesirable to shorten the spillway by the 80 ft. or more required for building a power house on the dam. On the other hand, a high cliff at the end opposite the lock made it impracticable to build the power house beyond that abutment of the dam. The problem was solved, therefore, by placing the power house over the dam and above flood level, supporting it on piers in such a way as to leave the spillway practically unobstructed.

In this design, the pits for the three hydraulic turbines are built with their roofs level with the crest of the dam. Over the wheel pits is a deck which supports the trash rack and is carried by the walls forming the upstream and downstream sides of the pits. Upon this deck, which forms a part of the spillway of the dam, are three piers about 50 ft. high, supporting the power house. These piers are centered directly over the turbines, the shafts passing up through the piers into the generator room, being thus protected from floating drift. At the outer or river end, the power house has a cantilever extension over the dam, while a similar extension at the shore end provides room for the switchboard and auxiliaries, and has a platform supporting a light steel bridge extending to the bank.

For handling the machinery in erection and for future repairs or replacements an unusual method was adopted. There is no railroad near the power-house end of the dam and the cost of a highway connection would have been prohibitive. It was decided, therefore, to have the machinery delivered by barges. For this purpose the power house was designed to carry a gantry crane of 15 tons capacity, traveling on the walls of the building. Its girder carrying the hoisting trolley has its ends cantilevered over the forebay and tailrace. With this arrangement, material is picked up from barges, carried to the proper position and lowered through roof hatches into the building. This crane also carries a rake for clearing the trash racks.

As the thickness of each pier is less than the diameter of the pit liners of the turbine, an arched opening is provided in the pier and the segmental top of the pit liner and sides of the arch are fitted with steel-plate covers, which can be removed to permit of lifting the turbine runner and its section of shaft until the bottom of the runner clears the top of the deck or roof of the wheelpit. The runner and shaft can then be moved sideways out onto this deck. To protect the deck from overflow while machinery is being assembled or dismantled, a single pair of head gates is provided, sufficient to shut off the water from one unit at a time. These gates are 6 ft. higher than the depth of the wheel-

pit and thus extend 6 ft. above the crest of the spillway, so as to divert water from that part of the deck which is in use for installing or dismantling equipment. These head gates are of steel, of the caterpillar type, and when not in use are laid horizontally across the top of the piers upstream from the power house by means of the gantry crane.

The old dam is of timber crib construction with a concrete deck. The wheel pits and power house are built on the downstream side and in order to join the river end of the pits with the crest of the dam, it was necessary to break through the concrete deck. With the power house site inclosed by a cofferdam, two rows of crib pockets were cleaned out by a derrick with orange-peel grab bucket and by divers, and were afterward backfilled with concrete deposited through a tremie. Upon the foundation thus constructed was built a wing wall extending from the wheel pit structure upstream to the crest of the dam.

In the power house, 21½x91 ft., are three generators with an aggregate capacity of 2,000 kw. Automatic control is provided by floats, but the machines can be controlled also from the Dix River power station. As the turbines are of the high-speed propeller type, with con-

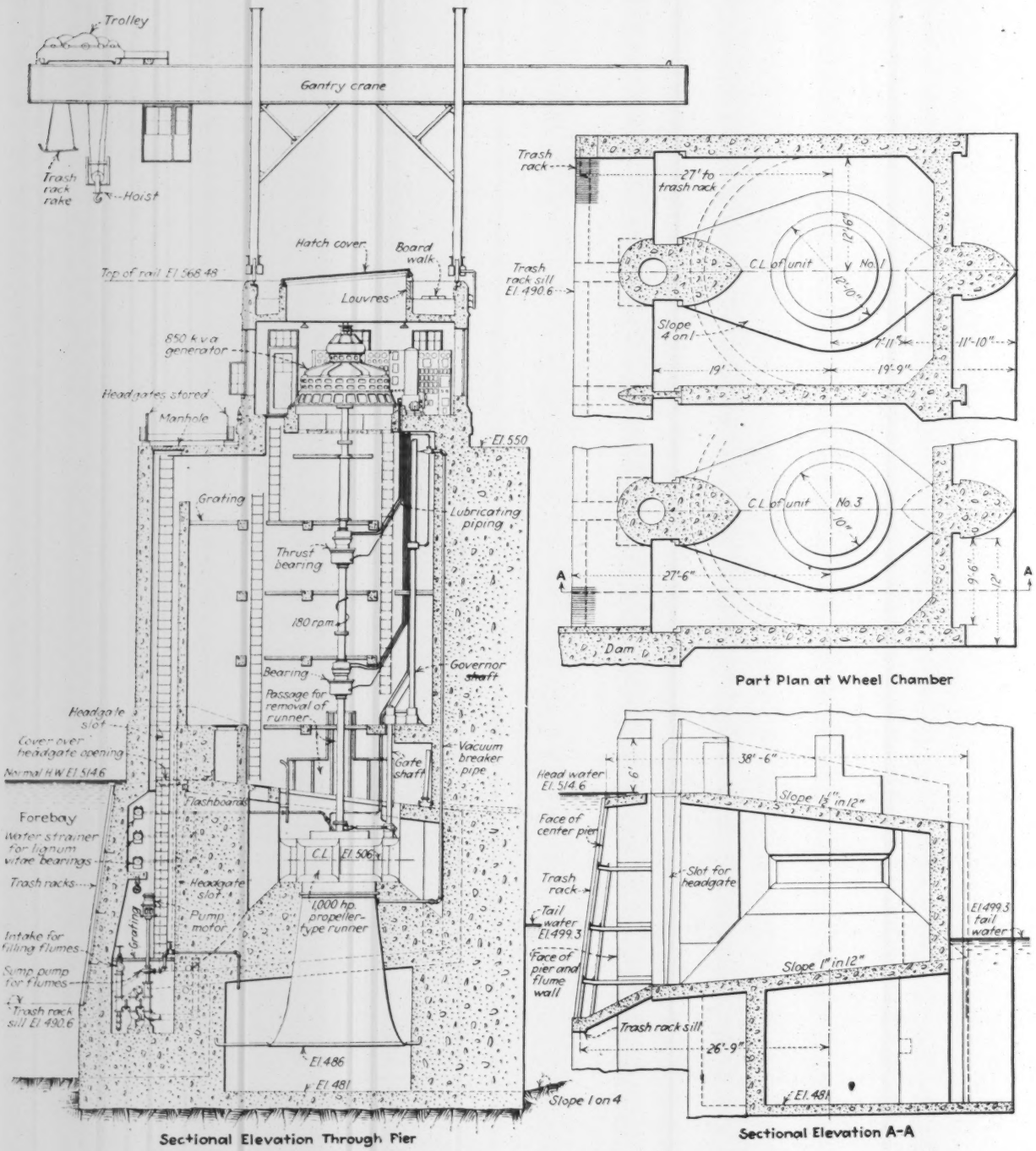


FIG. 2—HYDRO-ELECTRIC STATION AT DAM NO. 7, KENTUCKY RIVER

sequent low part-load efficiency, and the units are small in proportion to the system load, the control is so arranged that each unit will run normally at the most efficient gate opening. Thus whenever a unit is brought into operation either by the float or by supervisory control, it will open to the point of best efficiency, which can be set at the time of daily inspection for the then existing head, and will maintain that gate opening until shut down. This is effected by setting the governors to operate at slightly higher than system frequency, thus holding the gates always against the gate limit stop but still permitting the governor to close them in case of interruption of load.

As the headwater level rises, the three units will cut in consecutively at predetermined increases in head, which can be adjusted as desired. In the event of a rise of the headwater above what can be utilized by the turbines at normal gate openings, the gate limit stop on the governors is released automatically, allowing the turbines to open to full gate position for maximum use of the surplus water.

The design and engineering supervision of construction of this plant for the Kentucky Hydroelectric Company was in charge of L. F. Harza, consulting engineer, Chicago, and the general contractor was the L. E. Myers Company, Chicago.

Thames Flood Broke 265-Year Record

THE Thames flood of Jan. 6-7, 1928, in London, was higher by 11 in. than any flood for which records are available in a period of 265 years, according to a report by a governmental committee abstracted in London *Engineering* for March 9, 1928.

The first absolutely specific date mentioned in the abstract is 1663, when a flood occurred which the diarist Pepys characterized as the greatest remembered. The level then reached appears to have been 15 ft. 10 in. above ordnance datum. This held the record for 211 years, or until 1874. Just what level was reached in 1874 the abstract does not state, but only a year or so later (1875) the 1874 record was exceeded, water at Westminster Bridge rising to 17 ft. 3 in. above ordnance datum. Floods seem to have come thick and fast just then, the abstract stating that "other exceptional tides were recorded in the two succeeding years and as a result the construction of flood-protection works was decided upon and 17½ ft. was assumed to be the maximum level to be guarded against"; but the rampage of Father Thames was not yet over, for in January, 1881, the 17½-ft. level was attained, whereupon the flood-protection works level was fixed at 18 ft. above ordnance datum and works were built accordingly. For decades following this height seems to have been sufficient, since no actual flooding occurred, "although not a little of the protective works are necessarily of a movable character."

The flood of December, 1927 (17¼ ft. above ordnance datum), "was the highest in 43 years, and justified the assumption that the existing protection works were adequate." This was disproved Jan. 6-7, 1928, when "the level attained was no less than 11 in. higher than the abnormal flood of 1881, which was only 3 in. higher than the previous maximum reached in 1875." Specifically this new figure was 18 ft. 5 in. above ordnance datum. The extreme height was due to a combination of circumstances outlined in *Engineering News-Record,* Feb. 2, 1928, p. 207—that is, downcoming flood waters and what would naturally have been only a moderate high upcoming tide which was augmented by a tidal bore caused by long-continued high winds that piled up the water both from the north and from the south and drove it up the Thames.

How unexpected this combination was is indicated by the following quotation from *Engineering:* "The predicted height of the tide at London bridge was 12 ft. 5 in., but a level of 18 ft. 3 in. was actually attained. At Richmond, the normal height would have been 13 ft. 10 in., while the tide actually rose to 18 ft. 6¾ in. At Tilbury again, the water rose 5 ft. 6 in. above the predicted level, and both here and at London bridge high water was attained half an hour before the predicted time."

Increase in tide heights on the River Thames at up-river stations is indicated by ten-year averages, although down the river at Crossness (where one of the London sewage outfalls is located) the river "has remained sensibly constant." Further up, at Hammersmith, the average tide level increased from 11 ft. 8 in. for 1898-1907 to 12 ft. for the next decade and 12.2 ft. for the decade ended with 1927. This progressive rise is attributed to "river improvements" which have "facilitated the run upstream of the tidal waters."

As to the probability of the January, 1928, flood level being exceeded, the report states that existing data are insufficient for conclusions and advises that an expert study of the subject should be made by the Liverpool Tidal Institute in co-operation with the Hydrographic Department of the Admiralty and with the Meteorological Office, the cost to be shared by the Port of London Authority and the London County Council.

The report here abstracted was made by a committee representing the three authorities just mentioned, together with the Home Office and the Ministries of Agriculture, Health and Transport and "five of the local authorities more immediately concerned"—presumably the cities of London and Westminster and three of the boroughs making up the administrative county of London.

New Earth-Moving Record Claimed

An article entitled "New Excavating Record Made on Mine Stripping," appearing in *Engineering News-Record* of Oct. 27, 1927, p. 692, recorded the very creditable excavating record made by A. Guthrie & Company in the Mesabi Range of Minnesota. During the month of July, 1927, one of the Guthrie outfits loaded 244,710 cu.yd. into 30-cu.yd. cars in 57 ten-hour shifts, averaging 4,293 cu.yd. per shift. The shovel used had an 80-ft. boom, 52-ft. dipper handle and an 8-cu.yd. dipper. It was mounted on railroad trucks and handled the heavy glacial drift found in the Mesabi Range.

Information has since come to hand of an even greater record made by one of the outfits of the Winston-Dear Company, of Hibbing, Minn., in May, 1922. Using the same type of shovel, in the same kind of ground, this organization loaded out 260,853 cu.yd. in 54 ten-hour shifts, an average of 4,831 cu.yd. per shift. In the period from May to September, 1922, this same outfit loaded a total of 1,066,550 cu.yd., an average of 213,310 cu.yd. per month. These figures were given to *Engineering News-Record* by F. H. Holladay, vice-president and general manager of the Winston-Dear Company.

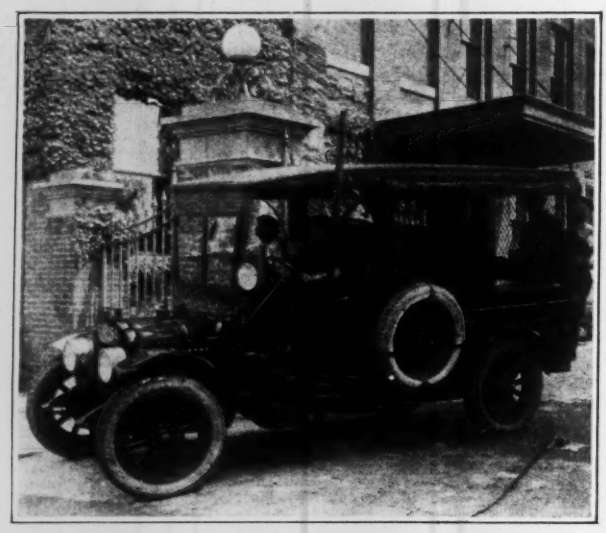
Extension and Operation of Water Distribution System of Springfield, Mass.

City Water Department Lays Mains, Sets Hydrants and Valves, Puts In Meters and Services and Makes All Repairs Under Office Force and Eight Other Divisions

When a Water Department makes all extensions to its distribution system, including mains, valves, hydrants, service connections and meters, and keeps everything in repair, as is done at Springfield, a quickly functioning force of men is required. The extensive storage yard and large service building at Springfield were described in *Engineering News-Record*, June 7, 1928, p. 896. The following article describes some of the special fittings and appliances used at Springfield and outlines the organization and operation of the nine field and service-building divisions of the maintenance and operation department.

—Editor.

EXTENSIONS, maintenance and repairs, including service connections and water meters, on the water-works system of Springfield, Mass., are made by the water department. As the system is under a rather high (gravity) pressure, normally reaching 150 lb. per sq.in. in the business and other lower parts of the city, careful construction to prevent leaks and prompt work to stop them is demanded.



EMERGENCY CAR, WATER DEPARTMENT OF SPRINGFIELD, MASS.

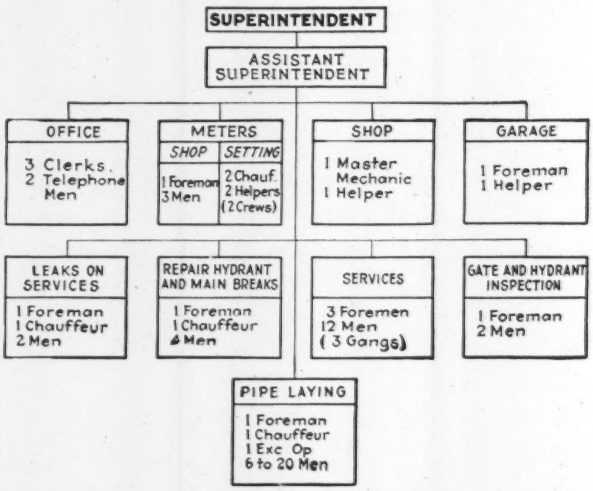
Always ready to rush to water main breaks or other trouble centers. Housed in service building shown in rear, together with other motor vehicles, repair shops and offices.

The pipe network includes about 265 miles of mains, laid uniformly 7½ ft. from the center line on the north and east sides of the streets. Both centrifugally cast and sand-cast iron pipe are used. Jointing material is a composition that has proved very satisfactory and eliminates the necessity for calking.

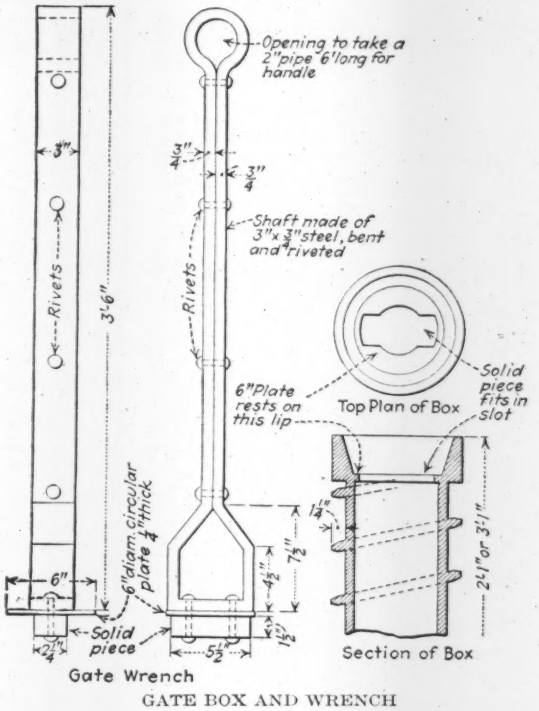
Valves at each street intersection permit closing down the supply to small areas when breaks occur or when repairs are made necessary. Usually valves are installed on a street line, so as to be easily located. Where the street lines are not readily determined, as in some outlying districts, a small precast reinforced-concrete post is placed in the ground, out of the roadway and directly opposite the valve. Cast with the post is a bronze plate upon which is stamped the distance out from the post to the valve. Valve boxes are of cast iron and are made in two sections. The top section, which embodies the rim and cover, has a spiral flange cast integrally with it on the outside. Raising or lowering the box after it is placed in the ground is accomplished by turning the top section by means of a specially built wrench. This valve box is free to telescope over the lower portion, and does not transmit a blow or jar to the valve. The large number of gate valves in use—more than 8,200, averaging more than 23 per mile of main—and their uniform location form an important factor in the maintenance of the distribution system. Each valve is operated at least once each year and the more important ones are operated oftener.

Practically every one of the 2,400 fire hydrants has an independent valve, permitting the hydrant to be removed or repaired without shutting down the main. This valve is flanged directly to a tee in the main, and in case a hydrant joint, which is usually of the bell-and-spigot type, is blown out or the hydrant broken off, the valve remains intact and permits shutting down the hydrant to make necessary repairs. All of the hydrants used are of a type that is designed not to leak even if the hydrant post or valve is broken off at the ground line.

To support the hydrant, two concrete blocks are used, one fitting directly underneath the hydrant and the other placed vertically against the hydrant barrel on the opposite side from the main. Instead of using a single size of hydrant, which is common practice in many cities, hydrants from 4 to 8 in. in diameter are used, the larger on large mains. In some instances the street department uses fire hydrants to fill street flushers or sprinklers, but this practice is gradually being done away with and separate 2½-in. sprinkler hydrants of the post type are



ORGANIZATION CHART SPRINGFIELD WATER-WORKS DISTRIBUTION SYSTEM



GATE BOX AND WRENCH

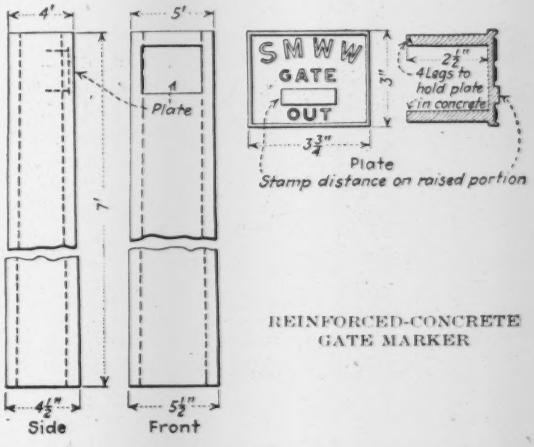
being installed for use by the street department. During the winter months all hydrants are inspected at least twice a week and those in the business district are inspected every two days to prevent any possibility of water seeping into the hydrant barrel and freezing. Early in the fall all of the hydrants in the system are carefully inspected and placed in proper working order.

Service connections embody a number of refinements which are made possible because the work is done by the department. The smaller services are of cement-lined wrought-iron pipe, while those above 2 in. in diameter are of galvanized wrought iron or cast iron. The largest size service permitted is 4 in. Genuine wrought-iron pipe is lined with cement by the department during the winter months or during slack periods. The connections to the main are made through bronze corporation cocks, usually the next size smaller than the service. Threaded onto a bronze tailpiece of the corporation cock is a wrought-iron lead-lined increaser, into which the cement-lined pipe is screwed. At a point inside the curb a bronze curb cock is placed in the service and the cement-lined pipe is continued into the building. Every service is metered. A stop-and-waste valve is placed between the meter and the building wall. Particular care is taken in the arrangement of the fittings to prevent water from coming in contact with unprotected surfaces of the wrought-iron pipe or the cast-iron main. The corporation cock is fitted with a plain nipple, which extends beyond the taper threaded portion and covers the newly cut threads in the main. The wrought-iron fittings are lined with lead in the shop by the department employees. The wrought-iron pipe and a coupling on one end are lined with cement at the same time. The plain end of the pipe is sweated with a coating of lead to protect the iron in case it does not fit firmly against the shoulder of the coupling, curb cock or stop-and-waste valve. Cement-lined services of this type were recently removed after 52 years of use and were found to be in excellent condition.

Until the introduction of galvanizing, cement-lined wrought-iron pipe was used entirely for small services. Galvanized-iron pipe then became the common material for water services and was used continuously until about four years ago, when a return was made to the use of cement-lined wrought-iron pipe. This change back to the cement-lined pipe was due to the frequent plugging of services from tuberculation, due partly to the character of the water and also to imperfections in galvanizing. Before stoppage occurred, however, a reduction in pressure would be apparent and complaints would result.

When a low pressure or the entire stoppage of flow is reported in any of these galvanized-iron services, the service is disconnected on the house side of the stop-and-waste valve in the building and a special tee is attached to the stop-and-waste connection. The outlet end of this tee is fitted with a stuffing box which will admit a ¼-in. brass rod. The branch of the tee has a ¾-in. hose thread permitting a hose to be connected to it to carry away the waste water. The brass rod is fitted with a cutter of about the same diameter as the pipe to be cleaned and is threaded so that additional rods can be fastened as the cutter is forced along into the service. By opening the stop-and-waste valve the water flows into the tee and out through the hose. Tuberculation or other stoppage is loosened by sliding the rod back and forth and is then carried out by the flow of water. If the service is laid in a straight line, it can be cleaned for its entire length. Occasionally a service may require cleaning a second time two or three years later, and some services have even been cleaned a third time. The use of cement-lined wrought-iron pipe, however, has been found to eliminate incrustation and the resulting stoppage of flow in small services.

Leaks in the distribution system are stopped as quickly as possible. For this purpose an emergency crew is maintained at all times in readiness to respond to any reports of leaks or breakages. During the daytime this emergency crew consists of the foreman in charge of the garage and his helper and any other men that may be needed. From 4 p.m. to midnight a foreman and two men make up the emergency crew in addition to a telephone man. From midnight to 8 a.m. there is only the telephone man on duty in addition to the watchman. In emergencies after midnight he calls out a foreman, who lives in one of the water department houses and is connected by a private telephone with the office, and a crew is at the scene of the break within a short time.

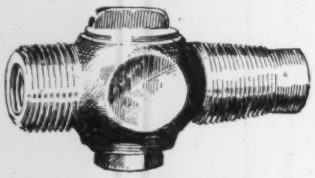


REINFORCED-CONCRETE GATE MARKER

Located in the service building office is a recording

pressure gage which is connected directly to the water main in the street. This pressure gage is equipped with a low-pressure alarm, which sounds when the recorded pressure falls below 50 lb. per sq.in. At the sounding of this alarm the emergency crew prepares to answer the call as soon as it may be reported to the office. A special ¾-ton truck is used. It is equipped with a mechanical valve-operating device and contains all the tools and equipment necessary to handle the average break.

The organization directly in charge of the distribution consists of nine divisions: (1) Office. Three clerks in the daytime, and two night telephone men, one from 4 p.m. to midnight and another from midnight to 8 a.m. (2) Meter shop. A foreman and three men clean, repair and test meters in the shop. (3) Meter setters and service cleaners. A chauffeur and helper on each of two trucks set new meters, clean services, remove and reset meters. (4) Machine shop. A master mechanic and a helper do all the necessary department machine work in a well-equipped machine shop. (5) Garage. The repair of motor vehicles is in charge of a foreman and a helper, who maintain all of the department's equipment. The department has eleven trucks—one 3-ton White, one 2½-ton White, six ¾-ton Whites, two ¾-ton Dodge and one small Maxwell—three passenger cars, and one air compressor mounted on a 1-ton Ford chassis. (6) Service leaks. A foreman has charge of leaks on services and also resets large meters. His crew consists of a chauffeur and two or three men. (7) Hydrants and breaks in mains. A foreman with a chauffeur and four men has charge of resetting and repairing old hydrants, laying new cast-iron services and repairing breaks in mains. He has three service gangs, each consisting of a sub-foreman and four men, which are used in putting in house services. (8) Gates and hydrants. In summer a foreman and two men inspect gates and check locations of stop boxes, while in winter the same crew inspects hydrants. (9) Pipe laying. A main pipe-laying gang, consisting of a foreman, a chauffeur, an excavator operator and from six to twenty men, as needed, takes care of extensions to the distribution system.



CORPORATION COCK WITH EXTENSION TIP

The operation and maintenance of the entire waterworks system is in charge of H. M. King, superintendent, and L. G. Carlton, assistant superintendent.

Results of Industrial Power Survey Announced

Recent figures made public by the National Industrial Conference Board show the distribution of installed horsepower in manufacturing establishments of the United States by kind, by location and by industry. A trend toward the purchase of power is evident, for the amount generated by the user has dropped to less than one-half the total power installed. Direct water power accounts for only 5 per cent, although a considerable portion of the purchased power comes from hydro-electric plants. In fact, more than one-third of the electric power generated in central stations is based on water power. The industrial area east of the Mississippi River and north of the Ohio River and the Mason-Dixon line contains about two-thirds of total installed horsepower in the country.

Flin Flon Railway Being Built With Unusual Speed

Materials Distributed Over Temporary Tracks on Frozen Ground—Work Now Being Pushed at Several Points

MUCH interest in Canada is centered at present in the building of the railway from The Pas, in the Province of Manitoba, to the famous Flin Flon mining property, a distance of approximately 90 miles. Ordinarily the construction of a railway of this length through sparsely timbered Northern country would occupy between two and three years. So important, however, was the element of time that the Hudson Bay Mining Company, the owner of the Flin Flon mine, when the contract for construction was signed on Dec. 1, 1927, offered a cash bonus of $250,000 if the line were completed and trains running before Dec. 31, 1928. The contractors, therefore, to speed up construction, entered upon the experiment of laying the ties and rails of a standard railway on the frozen ground for the first 50 miles. Dispensing with "tote" roads, they carried in all the materials for the building of the whole road and all the initial equipment for the mine before the spring thaw rendered the unballasted railway impassable.

The immensity of the task facing those in charge of the construction of this line may be better realized when the character of the country and the short space of time allowed for the completion of the line are taken into consideration. The first 50 miles of the right-of-way traverses a comparatively level area marked by muskegs and lightly timbered swamps, sections of which are almost impassable during the summer months. Beyond Mile 50 and to the end of the line, 38 miles further on, the country is broken, consisting of rock ridges with a fair growth of timber, and dotted with lakes.

With only a small amount of clearing and leveling, steel was laid on the frozen ground for the first 50 miles, enabling construction to reach the beginning of a system of lakes navigable for scows and rafts, along the shores of which runs the final stretch of this line. During the winter it was possible to operate trains from the main line near The Pas to the head of water transportation, and the material required for the completion of the line and for the opening up of the mine was moved in. With the spring break-up the heavy timbers will be floated to the site of the bridges and the machinery and other materials carried by scow to the various scenes of activity.

Three gravel pits were opened up along the first section of the road, and this spring and during the early summer the work of ballasting and lifting the roadbed will be pushed forward in both directions from each of these three points. Early in the operations camps were erected from Mile 50 to the end of the line at Flin Flon and gangs of men began the work of clearing, grading and bridging. The materials and supplies for this work were taken in from the end of the first section of the railway over a winter sleigh-road, the hauling being done by tractors and horses.

The line is being built by the Manitoba Northern Railway Company under charter from the Province of Manitoba. It will be leased on completion to the Canadian National Railways for twenty years under such terms that at the end of that time the line becomes the property of the operating company.

Eads Bridge Strength and Safety Indorsed by Engineers

Steel Unimpaired After 54 Years Service and Stresses From Maximum Modern Loads Within Designed Stresses

THAT the Eads bridge over the Mississippi River at St. Louis, Mo., is safe both as to condition of metal and as to strength to carry modern loading is the conclusion of a board of engineers appointed to investigate the condition and strength of the structure. This bridge, opened for traffic on July 4, 1874, has four masonry piers founded on bedrock, which carry two arch spans of 502 ft. and one of 520 ft., with a double-track railway on the lower deck and a highway with double-track electric railway on the upper deck.

Following the publication of a warning that the bridge was not adapted for its present traffic and train loads, this committee was appointed in September, 1927, by Henry Miller, president of the Terminal Railroad Association of St. Louis, which owns the bridge and operates the railway. The chairman was E. C. Hadley, chief engineer of the Missouri Pacific Railway, and his colleagues were the chief engineers of five other lines: R. H. Howard (Wabash), F. G. Jonah (St. Louis-San Francisco), H. J. Pfeifer (Terminal Railroad Association of St. Louis), C. D. Purdon (St. Louis Southwestern) and F. Ringer (Missouri-Kansas-Texas). This committee engaged J. N. Ostrom and J. M. Johnson, consulting bridge engineers, to make complete examinations of the physical condition of the bridge and calculations of the stresses to which it is subjected. Samples of the steel in the arch tubes of the bridge were submitted for analysis to Prof. Leroy McMaster, head of the department of chemistry at Washington University. It is pointed out that in 1902 there had also been a thorough examination of the bridge, by Mr. Ostrom, and an analysis of the stresses, by Prof. Malverd A. Howe, at which time it was reported that the bridge was in good condition and thoroughly safe.

Opinion of Committee—In concluding its brief report the present committee says:

"The history of the construction of this bridge, the investigations that have been made of it from time to time throughout its life and finally the investigations made by Messrs. Ostrom, Johnson and McMaster force the conclusion of the committee that the Eads bridge is today in excellent physical condition and amply safe for the loads and service it is called upon to carry and is carrying."

Mr. Johnson's Report—This report relates to a study of the maximum stresses in the arch spans and their relation to the safe stress for the various members. The conclusion reached is as follows:

"The arched ribs and the piers have stresses well within safe limits under the weights of equipment now being operated over the bridge and at the speed used of about 15 m.p.h. for tonnage trains. The greatest stresses obtained have been computed for the worst combinations, and under the everyday working conditions the stresses would be considerably reduced."

Mr. McMaster's Report—While analyses are given of some of the borings from the tubes, it is stated that there is no exact method of determining elastic limit and ultimate tensile strength from chemical analyses alone. However, calculations based on these analyses

EADS BRIDGE OVER THE MISSISSIPPI RIVER AT ST. LOUIS

Famour arch bridge built in 1874 by Capt. James B. Eads, which stands as a notable example of pioneer bridge construction. Its arch members are chrome steel tubes. Its safety, questioned last year, has been indorsed by an engineering board of investigation.

show a range of 98,000 to 138,000 lb. tensile strength, with corresponding elastic limit of 56,000 and 77,000 lb. respectively.

As to these figures the report says:

"These values represent ideal values, but may have little or no relation to the true values of the steels at present. There are no data available as to the physical constituents present in the steel, and these are the factors that control the physical constants of the material. Time may have destroyed all the benefits of heat treatment."

The analyses are said to show rather high-carbon chromium steel with, in the main, negligible content of manganese, silicon, sulphur and phosphorus. In twelve samples the range was as follows: carbon, 0.64 to 0.95 per cent; chromium, 0.57 to 0.68; manganese, 0.041 to 0.23; silicon, 0.056 to 0.138; sulphur, 0.006 to 0.013; phosphorus, 0.007 to 0.057.

Mr. Ostrom's Report—Numerous borings of the 18-in. arch tubes, which are built up of chrome-steel staves, are described in detail. The interior of the tubes, as examined by means of a special electric lamp inserted through 1-in. drill holes, showed much of the original asphalt varnish with which the tubes were sprayed during erection. In some places it had disintegrated, but all the tubes were found dry, with no evidence of moisture or of scaling or corrosion of the metal. While the metal was very hard in some cases, in others it was much softer. Measurements of twelve tubes showed a metal thickness of $2\frac{3}{16}$ to $2\frac{7}{8}$ in. In his examination made in 1902 Mr. Ostrom recommended covers for certain tubes where corrosion had been started by brine dripping from the upper deck. These covers, made of boiler plate, are now found watertight and with the exterior paint largely intact. None of the asphalt filling between tube and cover has run out at the joints, indicating that it is intact.

At coupling points on the tubes the vertical posts rest on the heads of eyebars forming the triangular bracing between each pair of tubes. The $\frac{1}{2}$-in. plate straps which hold the posts in place on the eyebars are the lightest important details, and Mr. Ostrom states: "While ample to resist uplift, they lack stiffness against lateral shifting and occasionally break. This . . . may take place without danger to the structure, as it would take a transverse butting blow to knock the foot of post off the eyebar heads." It is recommended that as these hitch plates fail they should be replaced by thicker or wider plates. In one span a broken $1\frac{1}{2}$-in. bottom-lateral rod was found. It was an old fracture, but as the rods are covered by the railroad track, only a special inspection would be likely to discover it. A few other minor defects are also noted.

As to the railroad floor, two additional lines of I-beam stringers, one for each track, were placed in 1925, and all work is sound and tight. But the horizontal wind trusses, of which the highway floorbeams are a part, have been neglected until the lateral rods and end diagonals are "seriously reduced in section." Immediate repairs here are recommended.

While the masonry piers and abutments are still in excellent condition, it is necessary that certain old cracks be grouted.

The following is Mr. Ostrom's general report somewhat condensed:

"His [Eads'] chrome steel has never been improved upon. Today the borings prove its toughness and the chemical analyses reveal that wonderful uniformity and qualities of high elastic resistance which we are all looking for. We are satisfied with it. We hang our faith upon it. Woodward's history shows that every stave was given a proof load of 50,000 lb. per sq.in. without taking a set or showing injury in any way. At first this was 60,000 lb., but was reduced to 55,000 and then to 50,000. I believe this because it was customary at that period. My first professional work was with the Detroit Bridge & Iron Works in 1877. At that time every finished eyebar was given a proof load before it was shipped. It was the custom of the time for first-class work. History records that Eads was a stickler for doing gilt-edged work and used every known safeguard. It is therefore reasonable to believe that every stave in the old bridge received a proof load before it was pressed into place in its envelope. This much of the history to prove that the chrome-steel tubes, the heart of the whole structure, are sound and of the highest grade.

"The old Eads monument has always been well cared for. It has not been loaded beyond its elastic safety. It is not deformed and buckled and twisted. It is not a streak of rust. It has received its daily cleaning and pot of paint. It is in good condition."

Present Stress Conditions—Each arch rib is composed of an upper and a lower tube, connected by wrought-iron diagonals or web members. In the 520-ft. center span these diagonals form 22 panels. In the calculations for the steel tubes, unit stresses of 50,000 in compression and 45,000 lb. in tension were adopted. The following quotation from Mr. Johnson's report refers to the center span:

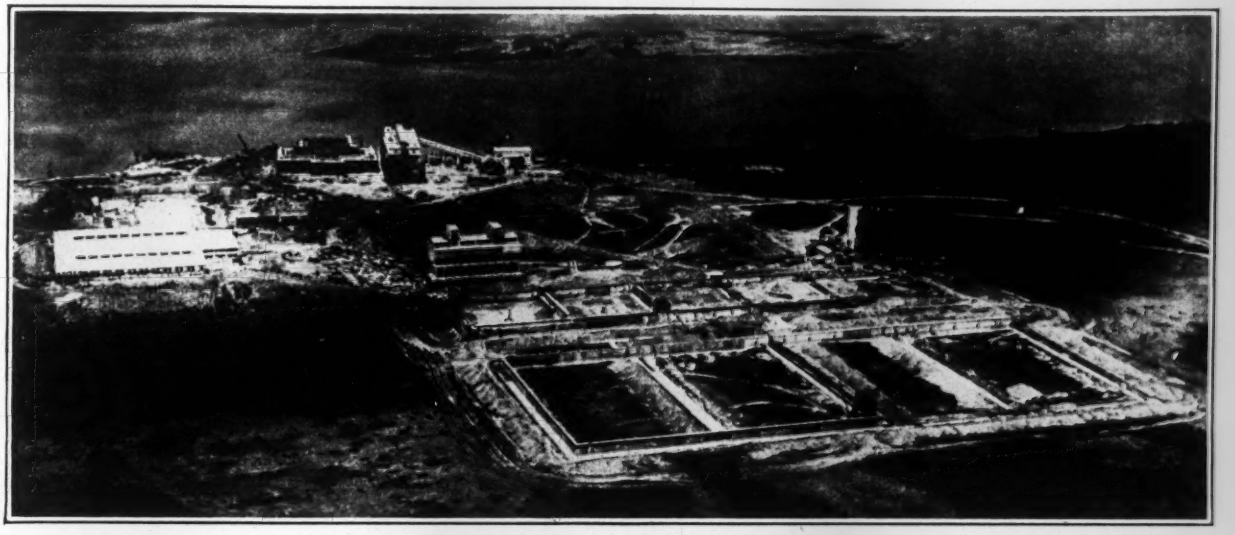
"For the lower tube the maximum compression occurs in member 0-1 [at the springing—EDITOR], with a unit stress of 39,700 lb. This is the maximum for both tubes and is 10,000 lb. less than the test load on each stave —a safe stress. For this tube, the maximum tension occurs near the crown, with a unit stress too small to have any special significance except as showing a stress reversal. For the upper tube, the maximum compression occurs at the crown, with a unit stress of 36,300 lb. The maximum tension occurs at the springing member, with unit stress of 18,100 lb.—likewise a safe stress."

For the wrought-iron diagonal or web members, Mr. Johnson's report states as follows:

"The greatest tensile unit stress is found in member 11-12, amounting to 18,000 lb., the corresponding stress in compression being 7,600 lb. The greatest compressive unit stress occurs in member 12-12, amounting to 17,700 lb., with tensile unit stress of 7,000 lb. The unit stress in compression, 17,700 lb., is practically the proof strength. It must be noted, however, that this stress was not obtained from the actual gross area, but from the area of the side bars alone. If the base of the T-bars [riveted to the side bars—EDITOR] be added, the stress reduces from 17,700 lb. to 14,200 lb. With this explanation of the seemingly high stress, it is believed all braces having tabulated stresses over 16,000 lb. are amply safe. The designers used for the gross section the area of side bars only, evidently considering the area of the T's as good measure. This procedure was followed in tabulating the stresses now found. The A.R.E.A. "Manual" suggests 22,000 lb. for good wrought iron as a safe working stress. The adopted unit for compression is 18,000 lb."

Water-Works Problems

Further Abstract of Papers Before the Forty-eighth Annual Convention of the American Water Works Association on Sources of Supply, on Protection, Purification and Analysis of Water, and on Management and Finance



GENERAL VIEW OF THE NEW WATER PUMPING AND PURIFICATION PLANTS OF THE ST. LOUIS WATER-WORKS
Located at Howard Bend, on the Missouri River, low-service pumps lift water from shore intakes to the sedimentation and coagulation basins, from which it passes through the filters and to high-service pumps

So NUMEROUS AND MEATY were the papers read before the American Water Works Association at San Francisco, Calif., June 11 to 18, that to the six pages of abstracts given in our last week's issue we add an equal amount of space below. This concluding installment gives interesting and instructive information and opinion from 25 papers, assembled in three main groups: Sources of Supply; Protection, Purification and Analysis of Water; Management and Finance. Main topics of the groups presented June 21 were: Pumps, Boiler Feed Water, Tanks and Reservoirs; Waste Prevention; Pipe and Other Elements of the Distribution System; Reports of Technical Committees; and summaries of data gathered by questionnaires on some twenty subjects, presented at the Superintendents' Round Table. In the dozen pages of our space, last week and this, devoted to the A.W.W.A. convention a hundred elements of water-works design, construction, management, financing and operation are covered, thus comprising a comprehensive survey of the vast water-works field.

—EDITOR.

Sources of Water Supply

INTERSTATE relations affecting sources of supply, some of the water problems peculiar to California and the Far West, an account of abandoning a filtered river water supply for well water, and one of the many examples of reforestation now going on, are the subjects of three papers. A brief summary of a lengthy paper on the additional water supply for St. Louis heads the group.

More Water for St. Louis

BY L. A. DAY
Water Commissioner

Completion of the new pumping and purification plant at Howard Bend, on the Missouri River, will give St. Louis two independent sources of water supply, either one able to meet the needs of the city. The main features of the new plant are two shore intakes, contrasted with the offshore intakes at Chain of Rocks; boilers and low- and high-service pumps; purification works, which include presedimentation, coagulation, softening, coagulation, filtration and chlorination, and also carbon dioxide treatment to prevent incrustation; a steel force main; and a large distribution reservoir. The ultimate capacity of the plant will be 200-m.g.d., but for a few years a delivery of only 55 m.g.d. will be required. The filters are designed for 80-100 m.g.d. capacity, with provision for enlargement.

Interstate River Compacts

BY DELPH E. CARPENTER
Consulting Engineer, Denver

Interstate river compacts are but an extension of the treaty-making powers between states authorized by the Constitution and exercised by some of the Colonies before its adoption in 1789 and by many of our states since then. Two paragraphs from the close of the paper set forth the scope of interstate river compacts and present an argument for their use as an aid to the continuation of state autonomy:

All problems respecting the use or disposition of the waters of an interstate river may be settled and usufructuary titles may be fixed in advance of conflict by interstate compacts and agreements covering: Preference of uses in times of scarcity; guaranty of the dominance of the more necessary uses over the less imperative; assurance to the states of origin of sufficient water from their streams to supply their future needs irrespective of the time or method of making

such uses; assurances of the permanence of the water supply necessary to the operation of works along the lower reaches of a river for municipal, agricultural, power or other purposes; comprehensive development of an entire river system in a manner best calculated to obtain the maximum benefits from the common water supply; making wasteful uses of water for purposes of navigation subservient to the more imperative needs of mankind; prevention of wastes; systematic regulation of all problems respecting the disposition, purification and other necessary control of sewage and other polluted waters. . . .

Our federal Union will endure or fail as the states are strong or weak. . . . The interstate river treaty method retains control of rivers with the states, where it belongs. It encourages harmonious intercourse between the states and mutual regulation of their own interstate affairs. It keeps government with the states and not at Washington. It preserves the states and perpetuates the nation.

A California Water Policy

By Edward Hyatt
State Engineer, Sacramento

Water is the one limiting natural resource of California, controlling all activities, whether agricultural, municipal or industrial. Additional water development in the state requires transmission to points of use, both involving such great difficulties—engineering, financial, legal, economic, administrative, political—that only under state direction can the work be done to the best advantage. Facts bearing on the need of a state water-supply policy have been gathered by the state engineer during the past seven years and a program has been made. About 96 per cent of the water not utilized goes for irrigation. The state has 23,000,000 acres of arable land, of which 12,000,000 is farmed and 6,000,000 irrigated. Exclusive of the Colorado River, the total mean annual water supply of the state is 72,000,000 acre-ft., which, if it could all be conserved and transported without loss, would be nearly enough for the 23,000,000 acres. Most of the water is in the northern part of the state and the bulk of the irrigable land is in the southern half. By means of a co-ordinated plan, including transportation of stored water, it is estimated that 18,000,000 of the 23,000,000 acres could be irrigated.

Filters Abandoned for Well Water

By E. T. Archer
Consulting Engineer, Kansas City, Mo.

Abandonment of a $300,000 filtration plant and substitution of a $191,000 groundwater supply of much softer water, not subject to pollution, is described to support the thesis that groundwater supplies "will undoubtedly be given greater consideration in the future than in the past, due largely to the development of the modern type well and pumping equipment." Shawnee, Okla., a city of 25,000, located 30 miles below Oklahoma City, on the North Fork of the Canadian River, and drawing 2 m.g.d. of water from that stream, is the example used. The river flows through salt plains and oil fields, gathering oil field drainage and also the "sewage of several towns," including that of "Oklahoma City, until recently untreated, and now receiving only about a 30-minute settlement," besides which there is "an almost uneradicable growth of algæ along the stream, causing an odor which cannot be entirely removed by aeration and treatment."

Filters Coped With Hard and Polluted Water—The first water-works, built in 1904, provided no treatment. In 1914 a 1-m.g.d. filter plant was built, and in 1920 a 3-m.g.d. Despite the use at the latter of 6.2 grains of alum and about 3.25 grains of lime per gallon, the water delivered to the city contained about 735 p.p.m. of solids, as well as some odor.

Well Supply—On 80 acres of land twelve 39½ to 47-ft. wells were sunk, with 30-in. outside and 15-in. inside casings, the space between filled with gravel, and the outer casing being gradually withdrawn to a level above the water-bearing stratum as the gravel was placed. In each well is a motor-driven centrifugal pump, from which a 4-in. discharge pipe leads to a 12-in. main emptying into a 1-m.g.d. concrete reservoir. The wells "have produced 3.5 m.g.d. continuously with no material interference." From the reservoir, duplicate 4-m.g.d. motor-driven horizontal centrifugal pumps force water through 2¾ miles of 20-in. main to a new 0.5-m.g.d. "water tower" in the city. The $191,000 mentioned at the outset covered the cost of the wells, collecting reservoir and force main to the city. The "water-supply development" was carried out by the Lane-Bowler Company, Memphis, Tenn. The general contractor was the H. L. Cannaday Company, Tulsa, Okla.

The location of the wells has reduced the pumping head from 230 to 178 ft., effecting a power saving of $215 monthly. There is also a monthly saving of $607 for chemicals and $375 for labor at the filter plant, making $1,198 a month, or $14,375 a year, to which should be added $25,000 for bottled water. Chemically the filtered and well water supplies compare as follows: Chlorine, 212 against 28 p.p.m.; hardness, 286 and 61; total solids, 753 and 125.

Reforestation of Watersheds

By Edgar P. Kable
Manager York (Pa.) Water Company

Reforestation in the drainage area of the impounding reservoir of the York Water Company, in Pennsylvania, has been carried on for some time past. At present there are about 700,000 evergreens—red and white pine, European larch, silver and Douglas fir, hemlock and Norway spruce—in flourishing condition. Experience shows that a three-year transplant is the best to use, as it has numerous and compact roots and a trunk flexible enough (compared with an older transplant) to permit the wind to sway it back and forth without creating an air pocket that may injure the young tree. With 100,000 such transplants set in a single year by the York Water Company, the loss the first year has been as low as 2 per cent, whereas with seedlings the loss has been as high as 30 per cent. A view showing some of the reforesting work around an impounding reservoir appeared on p. 962 of *Engineering News-Record*, June 21, 1928.

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Protection and Purification of Supplies and Methods of Analysis

THE never-ending quest for better water is reflected by the number and variety of papers on the subject read at the convention, some before the general sessions and fifteen before the water purification division. Among the most novel subjects presented were grappling with hydrogen sulphide and hard water at Beverly Hills, Calif., combating phenol tastes from creosoted wood pipe in Colorado, warding off ruin to an impounded supply in Texas threatened by very hard water from an irrigation system and by oil-well wastes, and the use of zeolite

for softening municipal supplies. Some papers on water analysis were also presented.

Pollution Diversion

By N. T. Veach, Jr.
Black & Veatch, Kansas City, Mo.

Protection of the water supply of Wichita Falls, Tex., from salt water from oil wells and from hard and otherwise highly mineralized water after its use for irrigation purposes has been accomplished by digging a ditch around the 4,600-m.g.d. impounding reservoir known as Lake Wichita and thus diverting the objectionable water. The reservoir was built about 1900, for irrigation, and is still largely used for that purpose. About five years ago a much larger reservoir, Lake Kemp, was built for irrigation. Contrasted with Lake Wichita, which has a total hardness of 63 p.p.m., all temporary, the water of Lake Kemp is very hard—71 p.p.m. temporary and 578 p.p.m. permanent.

About a third of the drainage area of Lake Wichita is irrigated with the hard water of Lake Kemp. The waste overflow from the irrigation ditches and the drainage from the irrigated land, until the diversion ditch was built, flowed into Lake Wichita. By limiting overflows from excess irrigation and keeping the groundwater level down, it is thought that the irrigation water reaching Lake Wichita can be kept down to the capacity of the ditch. There are some 500 oil wells on the drainage area, from which about 1,200 bbl., or 50,400 gal., of salt water is pumped daily, either to ponds for evaporation or into drainage ditches which naturally discharge into Lake Wichita. The net result is that, without diversion, there would be a yearly discharge into Lake Wichita of 60,500 tons of calcium carbonate (hardness) and 78,300 tons of sodium chloride. By emptying the storage ponds in dry weather the flow of salt water, it is hoped, will also be intercepted by the girdling ditch.

Recreational Use of Reservoirs, Helman Rosenthal, Director of Laboratories, Dallas, Tex.—Replies to a questionnaire show notably effective control of pollution in reservoirs used for recreational purposes. A more general use of reservoirs by the public could be permitted with safety if care were taken to know the condition of the raw water and to provide adequate treatment. No encouragement was given to admitting swimmers to large reservoirs at a considerable distance from the intake.

Progress in Water Chlorination

By L. H. Enslow
Research Engineer, Chlorine Institute, New York City

Information received from men in charge of chlorination at various plants, including Sir Alexander Houston, director of water examinations, London, England, are here summarized.

Prechlorination—Application of chlorine to raw or coagulated water, ahead of the filters, shows a marked impetus. In many instances it has relieved the strain on the filters by reducing the bacterial load due to sewage pollution. The practice seems to have reduced or controlled algæ growths. It has increased the length of filter runs, reduced washwater requirements and improved the general condition of the filter beds. In several instances reduction of the amount of coagulant has been attributed to chlorination, but this depends on local conditions and cannot be expected unless iron is present.

Super- and De-Chlorination — An excess dose of chlorine followed by de-chlorination at Toronto, Ont., was employed for taste prevention three months late in 1926, and resumed for continuous use, when needed, in June, 1927. On 167 out of 334 days, the treatment was used a whole or a part of each day, with no complaints of taste. Plans for a new 100-Imp. m.g.d. filter plant provide for the treatment. From information supplied by N. J. Howard, Toronto, it appears:

(1) The average amount of water treated at Toronto from June 13, 1927, to May 13, 1928, averaged 74.78 Imp. m.g. (2) The maximum dose of chlorine applied during the super-chlorination period was 2.5 p.p.m. and the minimum 0.8 part. (3) Corresponding doses of sulphur dioxide were 2 and 0.8 p.p.m. (4) The treatment was completely successful and a tasteless water was furnished to the consumers. (5) Super-chlorination provides a very high factor of safety. (6) The additional cost of super-chlorination was about $0.78 per Imp. m.g. (7) The combined maintenance and operation cost for sterilization and taste prevention treatment was $43,360, or $1.74 per Imp. m.g.d., which is subject to material reduction through purchase of chlorine in 1-ton containers [as will be done for the new plant].

Sir Alexander Houston, of London, after briefly comparing pre-ammoniation, chloramines, permanganate and super- and de-chlorination, pronounced the latter as "perhaps the most definite in preventing tastes and for rapid and effective sterilization," adding that "the process is perhaps best applicable to waters of high organic purity."

Algæ Control—Although "chlorine will probably not entirely supplant copper sulphate as an algæcide" it "has a high place" for the purpose and has the advantages over the older agent of "accuracy of application, sterilizing and oxidizing qualities and lower cost."

Other Papers on Chlorination

Algæ Control at Kansas City, Kan., L. B. Mangun, Chemist in Charge of Water Purification, Kansas City, Kan.—Chlorination three times a week of the influent to a 13-m.g. storage reservoir sufficient to give residual chlorine in the entire reservoir within ten hours gave such satisfactory results during the summer of 1927 that a proposed outlay of $125,000 to cover the reservoir is now deemed unnecessary.

Crenothrix Control by Copper Sulphate and Chlorine, Kenneth W. Brown, Sanitary Engineer, California Water Service, Stockton—Crenothrix in groundwater supplies pumped from deep wells for various California towns were combated with copper sulphate and chlorine.

Plankton in Reservoirs, Dr. C. A. Kofoid, University of California, Berkeley—In the control of plankton in Spring Valley reservoirs samples are collected twice a week in a silk net and results of the control work are plotted in graphs showing for various organisms the annually recurring flares of activity. Reports of experience from several members brought out the fact that, contrary to Dr. Kofoid's opinion, prechlorination may be of great value in plankton control. In one case of a shallow reservoir, prechlorination was very effective in reducing taste and odor after copper sulphate had failed. Lime, iron and alum are also found useful in reducing algæ nuisance.

Softening Plants and Special Problems of Taste and Odor Control

Zeolite for Water Softening, J. T. Campbell and D. E. Davis, The J. N. Chester Engineers, Pittsburgh, Pa.—Zeolite instead of lime and soda ash has been used in commercial and domestic supplies for some years, but

rarely for municipal supplies. The various zeolites, natural or synthetic, consist of combinations of iron, aluminum and sodium, largely as silicates, which have the property, when hard water is passed through a bed of the material, of exchanging their sodium for the calcium and magnesium in the water. When their sodium is exhausted, it may be renewed by washing the bed with a brine solution. Under the direction of the authors' firm, a zeolite plant has been built to soften the water supplied to 60,000 people by the Ohio Water Company, operating in suburban territory below Pittsburgh, and one is under construction for the Sewickly (Pa.) Water Company, supplying a population of 5,000.

The first-named plant takes about 3.2 m.g.d. water from wells drilled through 30 to 40 ft. of sand and gravel to bedrock beneath the Ohio River, the underground water being about twice as hard as that of the river flowing above it. The plant also removes manganese.

The four softening units are horizontal steel pressure tanks, 9 ft. in diameter and 22 ft. long, each containing 40 in. of zeolite sand on 18 in. of gravel. Each unit has a top area of 208 sq.ft. and operates up to 1.5 m.g.d. at the beginning and 1.1 m.g.d. at the end of a run. The cost of the plant and auxiliaries was $94,799, including engineering, overhead and interest during construction. The plant has been successfully operated 2½ years, and apparently the zeolite will last indefinitely, except for a small sand loss due to abrasion—about 100 cu.ft., or 3.7 per cent, in 2½ years. Robert Spurr Weston, of Boston, was consulted on the design of this plant.

Wash and rinse water have averaged about 10½ per cent of the plant output. The most economical salt dose seems to be 0.35 per 1,000 grains of hardness removed. Operating cost for the years 1926 and 1927 were $17.30 and $19.24 per m.g., and fixed charges (interest 6, depreciation 3 and maintenance 1 per cent) $7.90 in 1926 and $7.56 in 1927, or totals of $25.20 and $26.80 per m.g.

Another Paper, outlining laboratory studies of zeolite softening for municipal supplies, was presented by H. N. Jenks, professor of sanitary engineering, Iowa State College, Ames, Iowa. It reviewed the chemical and engineering principles involved and gave preliminary data and conclusions on design and operation.

Hydrogen Sulphide Removal and Water Softening, Ray L. Derby, Consulting Engineer, Los Angeles, Calif. —The principal water supply of Beverly Hills, Calif., is derived from wells containing hydrogen sulphide. The water is also hard. Growths of beggiatoa and sulphide-forming bacteria were troublesome. The latter completely nullified the benefits of aeration, the water uptown many times being higher in hydrogen sulphide than that leaving the aerator. A 0.07-m.g.d. experimental filter plant was put in. Aeration, retention for several hours, a dosage of lime and alum, and rapid sand filtration gave a satisfactory effluent with low hydrogen sulphide content. Based on the results of this experimental plant, a rapid sand gravity filter of 7.25 m.g.d. was built. It was put into operation in May, 1928.

Chloro-Phenol Tastes From Creosoted Wood-Stave Pipe, Dana E. Kepner, Director, Division of Sanitary Engineering, Colorado Board of Health, Denver—Experience at Canon City, Loveland and Pueblo, and experiments at Denver, Durango and Fort Collins, Colo., indicate that certain waters conducted through relatively new creosoted wood pipes and treated either previously or subsequently with chlorine in amounts customary for sterilization develop a characteristic chloro-phenol taste, whereas the same waters similarly chlorinated but not coming in contact with such pipes do not develop the taste. Among the various factors influencing the formation of the taste are: The amount of organic matter in the water—the less present the more decided the tendency for taste to develop; the amount of residual chlorine in the water as it enters the pipe, in the case of prior chlorination; and several factors which determine the amount of creosote taken up by the water in passing through the pipe, such as the newness of the pipe in point of service and the amount of contact.

At Loveland, 8 miles of 20- and 24-in. creosoted wood-stave pipe line produced a chloro-phenol taste in the filtered and chlorinated water passing through it. The taste was particularly offensive during the fall, winter and spring seasons, when the organic matter content of the water was low and the residual chlorine present as the water entered the pipe relatively high (0.1 p.p.m.). This continued from the time the pipe was installed in 1924 until the winter of 1927, when prechlorination was adopted. Prechlorination, at the coagulation basin inlet, during the winter of 1927-28 and the following spring, using chlorine at an average rate of 7 lb. p.m.g., with a resulting residual of 0.10 p.p.m. after four hours' detention in the settling basin but none after filtration, eliminated the taste. During the summer chlorination following filtration can be carried on without the formation of the taste, apparently because the residual chlorine (0.1 p.p.m. after ten minutes' contact) is so quickly eliminated by the organic matter present in the water.

Filter Plant Operation

Six Years' Operation at Peterborough, Ont., R. L. Dobbin, Manager Utilities Commission—A mechanical filtration plant of standard type, with a capacity of 6 Imp. m.g.d., was put in use at Peterborough, Ont., in February, 1922. Before reaching the pre-sedimentation basin the river water is pumped to and flows over a six-step aerator. There is a 2-Imp. m.g. clear water reservoir below the filters, from which water is pumped directly to the distribution system. The pumping rate ranges from 4 Imp. m.g.d. by day to one-fourth that at night.

For the first two years of use the plant was operated on three shifts daily, with one operator per shift. Since then the plant is shut down from 10 p.m. to 7 a.m., after which it is run at full capacity until the clear-water reservoir is full, then shut down until the water reaches a certain level, then started again. At first, the filters were washed whenever the loss of head reached 8 ft., ordinarily once in nine hours; but when the runs increased to 30

PETERBOROUGH AERATOR THE FIRST WINTER
Ice troubles caused shutdown of aerator after the first winter.

hours, in the fall and winter, the bacterial efficiency fell off. At present each bed is washed at least every other day, with good results.

The aerator was designed to remove odors. This it does to some extent, but its greatest value appears to be as an aid in mixing. The aerator was operated during the first winter, but so much ice accumulated on the steps that the flume overflowed. Since then the aerator has been bypassed in winter.

Sacramento, Calif., R. A. Stevenson, Superintendent Filtration Division—Raw water of a flashy nature and high algæ content is subjected to a prechlorination and split coagulation at Sacramento. Aftergrowths in the sedimentation basins are the rule after prechlorination.

East Bay Filters, California, Prof. W. F. Langelier, Berkeley, and Joseph De Costa, Oakland—Two 12-m.g.d. rapid sand filtration plants treat stored water of moderately high organic content, from almost uninhabited watersheds, of which 70 per cent are owned by the water company supplying Oakland and other communities. Manganese and algæ have to be reckoned with. Circular mixing basins at the newer plant, similar to those at Sacramento, give satisfactory results. Air wash has been added to the filters, partly on account of manganese incrustation. This required careful leveling of the underdrains, since even $\frac{1}{4}$ in. difference in level in a length of 14 ft. impairs distribution.

Circular Mixing Basins, Knoxville, Tenn., W. W. Mathews, Assistant Engineer, Alvord, Burdick & Howson, Chicago—Mechanical agitators in circular coagulant mixing chambers at the new filter plant at Knoxville, Tenn., reduced the unit cost of chemicals in the last quarter of 1927 compared with the similar period in 1926.

Chemical and Bacterial Practice

Reactions of Sodium Aluminate, A. M. Buswell, Chief Illinois Water Survey, Urbana—Present data indicate that the reaction is not a hydrolysis and is therefore not similar to the reaction of aluminum sulphate. Experiments to determine the effect of varying the ratio between magnesium and aluminate and between calcium and aluminate indicate that a 1 to 1 ratio when expressed in chemical equivalents gives the largest amount of precipitate. This appears to indicate the formation of magnesium aluminate and calcium aluminate, but further experimental work will be necessary to establish this point definitely.

New Method for Determining Dissolved Oxygen, F. R. McCrumb and W. R. Kenny, Research Chemists, LaMotte Chemical Products Company, Baltimore, Md.—Orthotolidine gives variable shades of color in the presence of certain oxidizing agents, such as free chlorine and hypochlorites. It has been found that under proper conditions the manganese reaction with orthotolidine is a quantitative one, and hence, by means of a modification of the Winkler method, dissolved oxygen can be determined following a procedure which permits the use of color standards representing various amounts of dissolved oxygen. This method is particularly useful when it is desired to determine amounts of dissolved oxygen under 0.5 c.c. per liter, as in the control of boiler water. However, by a suitable procedure larger amounts can also be determined satisfactorily.

Differentiation of B. Coli and B. Aerogenes, Dr. A. J. Salle, California State Department of Health, Berkeley—To differentiate B. coli and B. aerogenes (intestinal and soil bacteria, respectively), the principle of the methyl red test of W. M. Clark, (*Jour. Biol. Chem.*, 22: 87, 1915) in the form of a solid streaking medium has been made use of by the writer. (*Jour. Infectious Diseases*, 41: 1, 1927.) The agar is composed of erythrosine, methylene blue and brom-cresol-purple incorporated in a lactose agar base. There is present sufficient lactose to satisfy the carbohydrate requirements of B. coli but insufficient for the needs of B. aerogenes. As a result, B. coli will grow and produce sufficient acid to change the color of the brom-cresol-purple from purple to orange or yellow, and at the same time produce a metallic sheen to each colony. On the other hand, B. aerogenes will not produce its maximum acidity, due to insufficient lactose and, therefore, produce neither a change in the color of the agar nor a metallic sheen. This medium has been in use for a period of about two years and has produced excellent results.

* * * * *

Management and Finance

MORE attention than usual was given to management and financial problems and methods. Besides the four papers abstracted below, data on these or closely allied subjects were given in the summaries of questionnaires, presented at the Superintendents' Round Table (see *Engineering News-Record*, June 21, 1928, p. 966).

Water-Works Management, George H. Fenkell, General Manager and Chief Engineer, and D. C. Grobbel, Chief Clerk, Detroit Water-Works—The business of a water department is to obtain and disburse funds for capital outlay, fixed, operating and maintenance charges and to collect and utilize engineering and other data for directing the work of the department, all in a manner that will meet the approval of at least a considerable part of the residents of the community. Of primary importance is obtaining employees through civil service; next to this is an adequate engineering force. Frequently a bureau of purchase and supplies will effect substantial savings.

Discussion—That it is often undesirable to have water department buying done by the city's purchasing agent was brought out by several speakers. W. W. Brush, New York City, said that a centralized purchasing department is a costly mistake in any municipality where that department does not have a personal interest in the work to be done. It would be far better, he said, to have the central agency draw up plans and specifications for any certain article, making these plans and specifications available to the various departments.

Diversion of Water Funds, Howell Wright, Director Public Utilities, Cleveland, Ohio—Use of water-works funds for other than water-works purposes is not only contrary to sound administration but is a positive menace to the very structure upon which the operation of the water-works business is based. It is "legalized imposition," or, as Raymond says in his book "The Public and Its Utilities," it is an "enforced gift of the private consumers." A brief review of practices in fifteen representative cities throughout the United States shows that such diversion of funds, or at least "free water" to other city departments, is common, whereas a water-works, as also any other publicly owned utility, should be paid for every service it renders and pay for every service it receives.

Discussion—W. W. Brush stated that a danger in municipal water-works operation is the tendency of city officials to divert water revenues to expenditures in other departments. This is believed to be illegal—if the rates are high enough actually to build up a surplus, the water users are entitled to a reduction.

Financing Extensions in Areas Temporarily Unremunerative, N. B. Jacobs, Vice-President, Morris Knowles, Inc., Pittsburgh, Pa., and Charles L. Fox, Assistant Superintendent, Pennsylvania Water Company, Wilkinsburg—A review of court and utility commission decisions and of the practice of the water-works themselves, on financing extensions into partly unremunerative territory, made in 1905 by W. C. Hawley, chief engineer, Pennsylvania Water Company, showed a diversity of opinion and practice. Only two states, New Jersey and Oregon, seemed to have mandatory rules on the subject. A questionnaire sent to water companies in Pennsylvania showed that of the 50 which had a definite policy as to financing extension about half required a deposit, with partial or complete refunding later on. As to decisions of utility commissions, they were, until the last few years, generally more favorable to the property owner than to the utility, but of 23 more recent extension cases reported in "Public Utility Report Annotated" the complaints were dismissed in eighteen instances.

Discussion—Every dollar spent on an extension, said ex-President Gibson, of Charleston, S. C., not only must earn interest on the extension but also must bear its share of burden in carrying the development as a whole. In Charleston, for each dollar spent on an extension, a return on $3.33 must be earned. It is good practice even to go beyond this basis of rating and to require the consumer to guarantee the cost where the extension is outside the city or where any unusual element of uncertainty is involved.

Water Sale Campaigns, Lewis W. Britton, Associate Editor, *Domestic Engineering,* Chicago—Use of water may be stimulated by addresses before Kiwanis, woman's and other clubs stressing the health and sanitation benefits of the extended use of water-supply house fixtures.

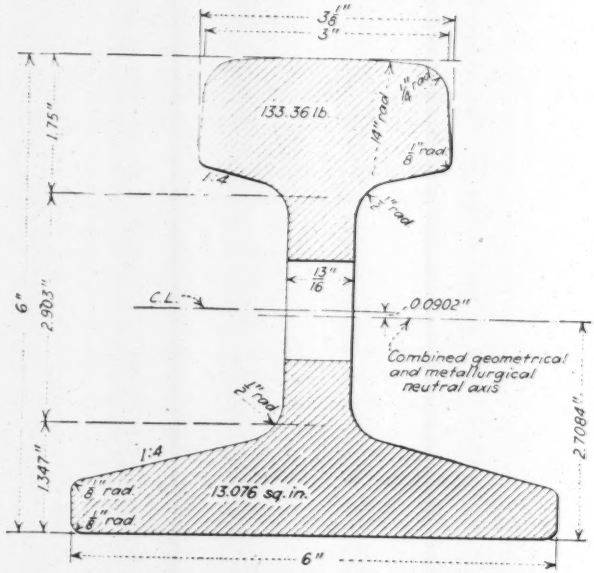
A Proposed New Rail Section

ALTHOUGH rail sections are now fairly well standardized, a new form of section has been designed recently with the special aim of preventing the arching of the rail on the cooling beds and thus eliminating certain stresses in the rails. This design is the invention of H. F. Roach, St. Louis, Mo., who is also the inventor of the Roach rail-joint (*Engineering News-Record,* Dec. 1, 1927, p. 885) and other railroad devices. A typical rail is shown in the accompanying drawing, and a comparison of dimensions is given in tabular form. The following is a summary of a statement as to the purpose of the design.

Present rail sections after passing the finishing rolls have two unfavorable conditions: (1) The web is so thin that it comes out black, occasioning high internal strains as between the head, flange and web. (2) In cooling on the hot beds, the head of the rail arches around the base to such a degree that it is necessary to bend the rail cold by gagging, to make it reasonably straight. This latter action consumes about two-thirds of the strength of the steel before it leaves the mills, and as the gagging is done in short distances, a series of arcs exist with the head slightly indented at each gag, inducing nuclei that in service may develop into transverse fissures.

An explanation of the difficulty is that the metal is so disturbed that the center of summation of mass or resistance is not coincident with the resultant of the cooling forces of the rail, thereby making an eccentricity that is quite powerful. That which is ordinarily called a neutral axis is here termed a geometrical neutral axis, as it is the expressive center of geometric resistance value of the section. The location of the resultant cooling power of the section is called the metallurgical neutral axis. It is obvious that these two axes must coincide in order to avoid the rail arching on the cooling beds. In this way a stronger and stiffer rail is produced with the same quantity of metal.

As to the web in present sections being so thin that it is black when it leaves the finished rolls, this induces internal strains and also brings the pressure of the rolls on the cold web, while the pressure is needed on the hot head in order to make a better, finer and harder steel. Thickening the web in the proposed section minimizes internal strains and affords opportunity for better metal in the head of the rail.



ROACH RAIL SECTION: 133.36 LB. PER YARD

COMPARISON OF RAIL SECTIONS

	Roach	A.R.E.A.
Weight, lb. per yard	133.36	130
Width of base	6 in.	6 in.
Height	6 in.	6 9/16 in.
Depth of head	1.750 in.	1 11/16 in.
Depth of web	2.903 in.	3 1/16 in.
Depth of base	1.347 in.	1 5/16 in.
Height to neutral axis	2.7084 in.	3 5/16 in.
Thickness of web	13/16 in.	5/8 in.
Radius, top of head	14 in.	14 in.
Radius, top corners of head	1/4 in.	1/8 in.
Radius, bottom corners of head	1/8 in.	1/8 in.
Radius, top fillet	1/2 in.	1/2 in.
Radius, bottom fillet	1/2 in.	1/2 in.
Radius, corners of base	1/8 in.	1/8 in.
Sides of web	Vertical	14 in. rad.
Fishing angles	1:4	1:4
Metal in head	38.15	36.4
Metal in web	14.35	25.8
Metal in base	47.50	39.8

Mount Hope Bay Bridge

In an article on the design of the Mount Hope Bay suspension bridge, *Engineering News-Record,* April 12, 1928, p. 585, it was stated "the securities are guaranteed by Pittsburgh financial interests allied with the contractors." This is incorrect. The statement should have read: "The completion of the bridge and performance of the contract are guaranteed by R. B. Mellon, H. H. McClintic and C. D. Marshall.

Letters to the Editor

A Forum for Discussion of Views of Engineers and Contractors

Avoid Overconfidence in the Grouting of Dam Foundations

Sir—Some stress has been placed on the fact that no attempt was made to seal the foundation of the St. Francis dam by grouting. In the light of considerable experience with pressure grouting of more or less porous rock formations, the writer is of the opinion that grouting in connection with high dams should be considered only as an extra or precautionary measure to aid in preventing loss of water by seepage or percolation. Grouting may be highly successful in firm rock having definite cracks and seams where there is no water moving under pressure, but it is of doubtful efficiency in rock formations such as conglomerate. The stability of great dams, therefore, should be made dependent upon some more certain and more positive measures.

One of the most extensive attempts yet made in the way of pressure grouting was in the construction of the Estacada dam in Oregon, sixteen years ago. There the foundation material was strong enough to carry the load to which it would be subjected, but the breccia was more or less porous. Since percolation would not menace the safety of the structure, the only question to be weighed in considering grouting was whether the water which might otherwise be lost through percolation would justify the expense of the grouting.

The grout was put in and after all these years the dam still stands without any observable amount of leakage through the foundation. Whether the seepage would have been of any considerable importance in the absence of grouting no one can say.

Lazarus White said (*Trans.* Am.Soc.C.E., 1914): "Where the rock is hard with definite seams and channels, the grout can be forced into it readily. Where it resembles the volcanic rock under the Estacada dam, it may run a long way from the area to be grouted and in excavating this part very little of the grout will be found. No one knows where it went. . . . If grout is forced into a place where there is water under pressure and if the water is circulating, it will carry the grout out of the seams before it has a chance to set. Grout has been chased over tunnel arches, up and down, for hundreds of feet. Before the grout is set it may be forced out and pipes and seams which were thoroughly grouted may become empty." In this connection, an article of interest on the grouting of the Lahontan dam by D. W. Cole appeared in *Engineering News*, 1913 (first half), p. 647.

In another case that came under the writer's observation grouting was attempted in the endeavor to stop unexpected seepage through conglomerate after a structure had been completed and put in service. There the results of grouting were decidedly negative and reinforced concrete had to be supplied to make good the deficiency. H. A. RANDS.

Portland, Ore., June 9, 1928.

Computation of Backwater Slopes

Sir—The experimental verification by C. I. Grimm of his method of calculating backwater slopes above dams (*Engineering News-Record*, June 7, 1928, p. 902) encourages me to suggest a more general form of the same method which recently saved a great deal of expensive surveying and laborious computation and the publication of which has hitherto been delayed until the calculated results could be verified by tests.

For any given reach of a canal or river in which there is continuity of flow, a transposition of the Manning formula, or of the Kutter formula with the slope terms omitted and combined with the Chezy formula, will give an expression for the difference in water level, h, between the ends of the reach, in the form $h = kQ^2$, where k includes the roughness of the channel and is a function of its physical dimensions and therefore is a function of the mean elevation of the water surface in the reach. Note, too, that k may be considered to include a summation of the various eddy losses and velocity head changes, which depend on the square of the velocity at different points in the reach. The formula will have its greatest accuracy for a deep channel with small variation in stage, but even with considerable departure from these ideal conditions it may well contain more accuracy than does the ordinary method where ideal survey results are unattainable and where the coefficient of roughness changes with the stage.

If one has a good set of gage readings at each end of the reach for a suitably wide range of flows, it is possible to plot a curve with values of k as ordinates and values of mean elevations in the reach as abcissas. This curve is asymptotic to the axis of abcissas, and it can be extended by calculating additional values from the gage rating curves, extended if necessary in the usual way. It can also be extended directly in the same way as are the rating curves, and apparently with the same degree of accuracy. Gage rating curves and flows in the reach can usually be determined with sufficient accuracy by correlation with the principal metering station on the river. It may be remarked that a good set of gage readings will give a much better set of points through which to draw the curve than one gets by drawing the average rating curve.

Finally, knowing the flow and the backwater elevation at the lower end of the reach, assume a mean elevation: Read from the curve the corresponding value of k and calculate h from the equation. Calculate the corresponding mean elevation and compare it with that assumed, making further trials to obtain agreement.

Similar methods can be applied to extend the backwater curve through rapids which are to be only partly drowned.

Finally, sets of backwater rating curves can be drawn through points obtained by other similar calculations with very little trouble.

It is evident that the application of these principles eliminates a great deal of field work, and the more irregular the river the greater is the saving in cost and the greater is the accuracy of the results in comparison with those obtained by customary methods. J. B. MACPHAIL.

Montreal, June 17, 1928.

Capacity of European Turbines

Sir—In your issue of June 7, p. 908, mention is made of what is claimed to be the largest turbines yet installed in Europe. The Kaplan turbines in the new plant of Ryburg-Schwörstadt on the Rhine in Switzerland, four in number—not three, as stated in your article—are given as developing 1,000 hp. for each meter fall. As those turbines, built by Voith, Escher Wyss & Cie. and Ateliers des Charmilles, are rated at 36,400 hp. by 12.3 meters (40.3 ft.), their capacity is 2,960 hp. per meter, or 900 hp. per foot of head, instead of 1,000 hp. per meter, as in your article. Runner diameter will be 7 meters (23 ft.). The corresponding values for the Lilla Edet Kaplan turbine of 14,140 hp. and 6.5 meters (21.3 ft.) is 2,175 hp. per meter, or 663 hp. per foot. Runner diameter is here 5.8 meters (19 ft.). The value of 676 hp. per foot head, not per meter, is the capacity of each of the two Lawaczeck turbines installed at Lilla Edet.

In this connection it is interesting to note the large number of Kaplan installations in Europe, particularly in Germany, Austria, Switzerland, Italy, Sweden and Finland during the last couple of years. In Germany the ratio of propeller turbines installed to Kaplan turbines is about 1:4.5. The tendency is also much toward higher heads for propeller and Kaplan turbines, especially for the latter. Two Kaplan turbines were built by Voith of 2,000- and 4,400-hp. capacity for 15-meter (49.2-ft.) head for the Bober-Ullersdorf plant. Two Kaplan turbines of 15,000 hp. by 15.4-meter (50.5-ft.) normal, 19.4-meter (63.6-ft.) maximum head, are being built by Kristinehamn for the Munkfors plant in Sweden.

Regarding capacity of European Francis turbines, no such large units have been built as are now in operation in other parts of the world, particularly in the United States and

Canada. The largest runners built in Europe are perhaps the two by Voith of 58,000-hp. capacity by 93-meter (305-ft.) head for a Canadian plant. The largest installed units within Europe are the Shannon River, Ireland, 38,600-hp. capacity turbines by 33.7-meter (110-ft.) head built by Escher Wyss & Cie. The Imarta Falls, Finland, turbines with 27,000-hp. capacity by 24-meter (78.6-ft.) head, built by Kristinehamn, are next in size.

The highest head Francis turbine installation is at present the Vemork-Rjukan I plant in Norway, where the latest installed Escher Wyss unit, the twelfth, of 17,500 hp. designed for 280.5-meter (920-ft.) was tested up to 293-meter (960-ft.) head.

Of high-pressure spiral type turbines some large units are being installed in Italy. At the Cardano plant are five units of 45,000 hp. each by 155 meters (509 ft.) built by Riva; at the Gallato plant there are being installed, initially, two units of 50,000 hp. by 197 meter (646 ft.) built by Escher Wyss & Cie.

The highest turbine efficiencies so far reached in European installations are to be found at the Mörkfos-Solbergfos plant in Norway, where 11,500-hp. 21-meter (69-ft.) Francis units of Kvaerner Brug make gave 94.4 per cent.

Kaplan installations have in several instances shown efficiencies up to 92.5 per cent and maintained around 90 per cent over very wide range of gate.

JOHN V. ZAHLEN,
Field Supervising Engineer,
Devils River Hydro-Electric Development.
Del Rio, Tex., June 12, 1928.

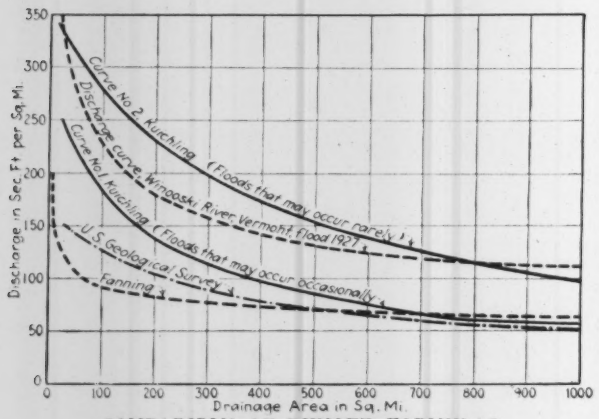
Spillway Capacity That Should Be Provided for Dams

Sir—The article "Runoff Figures in Vermont Flood Reach High Values," by H. B. Kinnison, district engineer, U. S. Geologic Survey, Boston, Mass. (*Engineering News-Record*, June 7, 1928, p. 890), calls timely attention to a very important yet often neglected feature of the construction of dams—namely, the area of the opening to be provided for the passage of excessive flood flows.

The accompanying illustration, designated as "Comparison of Runoff Formulas," shows the runoff in cubic feet per second, computed by well-known formulas, that may occur during excessive floods. By way of comparison, the actual runoffs as observed at different points along the Winooski River during the flood of 1927 are also shown.

It will be noted that the curve indicating the flood flows at different points along this river actually exceeds that estimated by Kuichling's formula No. 2 for areas greater than about 800 square miles, also for small areas less than 20 square miles. For the intermediate areas the observed flows of the river were not materially less than those corresponding to Kuichling's Formula No. 2.

Twenty-five or thirty years ago it would have been quite difficult indeed to convince the average hydraulic engineer that spillways for dams should be designed to safely pass floods equal to or even approximating those corresponding to Kuichling's formula No. 1, and as for formula No. 2, that would have been considered beyond all reason. In this connection the writer recalls quite vividly the severe criticism of the plans for an important dam because the spillway thereof had been designed by him with sufficient capacity to carry floods corresponding to Kuichling's formula No. 1.



COMPARISON OF RUNOFF FORMULAS

In view of the experience gained in past years and especially through the Vermont flood of 1927, it would appear the part of wisdom to design the spillways of important dams, especially those constructed of earth, so as to safely pass floods corresponding in severity to those upon which Kuichling's formula No. 2 are based.

The writer was familiar with the painstaking methods employed by the late Emil Kuichling in deriving the formulas, and he considers them to be quite reliable.

It would be interesting and instructive to know how many of the important dams in the East have spillway capacity sufficient to pass safely floods of the severity of the Vermont flood of 1927.

ALFRED S. BURGESS,
Yonkers, N. Y., June 12, 1928. Civil Engineer.

Cause of Breaks in Cast-Iron Water Mains Still Unsolved

INQUIRIES as to the cause of recent breaks in cast-iron water mains of Harrisburg, Pa., and Detroit, Mich., indicate that the causes of these and other breaks is still a mystery.

In Harrisburg, a break in a 36-in. main, 1½ in. thick, locally described as the fourth break in the local water mains, occurred in the middle of April last. As to the cause of these breaks, James H. Fuertes, New York City, consulting engineer to the Harrisburg Water Department, writes *Engineering News-Record* as follows:

Two of the breaks occurred where the return main crosses one of the basins of the old Pennsylvania Canal. The new 36-in. line was laid in the identical position occupied by the original pipes, put down in 1871, or 57 years ago. The pipe line had no bends and has none today. The pressures vary from 84 to 122 lb. per sq.in., depending upon whether connected directly with the pumps or with the high-level reservoir. The other two breaks were on a line part way up a hill, going east. One was on the force main and one on the return main, on a bend. The one on the return main has a backfill of about 7 or 8 ft., not enough, in itself, to cause the trouble. All the breaks on the return main occurred on a Sunday morning when there had been no pumping for several hours. The break in the force main was in a pipe laid about four years ago. The other breaks occurred in new pipe from one to three months ago.

It is impossible to fix a definite reason for the breaks that will stand up in view of all the facts in the case. There are always a great many things to consider in such breaks to arrive at the cause. As a rule, the break destroys all evidence of the cause of the trouble, and mere guesses or surmises are easy to make.

At Detroit, the break was in a 4-ft. main (repairs outlined in *Engineering News-Record*, May 3 and 17, 1928, pp. 712 and 794). The following information and comment is by George H. Fenkell, general manager, department of water supply:

The pipe is Class C, A.W.W.A. standard, 1¾ in. thick. At the time of the break the pressure at that point was about 50 or 55 lb., which is very moderate. The pipe was laid ten years ago and many times since it was put into service the pressure was higher than when the break took place. The soil beneath the pipe was firm clay, and I cannot account for it because of failure of foundation. The line of the pipe was near the curb and the traffic that the street carries is not high.

This department has had its share of broken water pipes during the years that are past, and it is very seldom that it has been possible to determine the cause for any of them. They nearly always are at the hub or bell end of the pipe and the split continues back 4 or 5 ft. and curves around toward the bell again, so that the broken piece is in the form of a slab and the line of break may not extend back to the hub entirely on one side. Granting that cast-iron pipe is more durable than steel, the water departments are forced to use steel pipe in the larger sizes to prevent breaks.

News of the Week

Current Events in the Civil Engineering and Contracting Fields

Dallas Lets First Contract for Trinity River Control

Following the recent sale of $6,000,000 worth of City of Dallas, Tex., bonds to a syndicate of bankers, contract for the construction of the levee system along the Trinity River was let to the Trinity Farms Construction Company, of Waxahachie, Tex., at a price slightly in excess of $4,325,000. Control of the river by the levee construction will reclaim about 7,000 acres of land in the heart of Dallas and in close proximity to the downtown freight terminals, making the land available for industrial and commercial uses and incidentally affording a means of some relief from existing traffic congestion. The floodway between the levees varies in width from 2,000 to 3,000 ft. and may be utilized for automobile parking or for development by the Park Board. The unit figures under the contract were as follows: Channel excavation, 12c. per cubic yard; muck ditch, 12c. per cubic yard; removal of dumps and fills, 12c. per cubic yard; construction of 30-ft. levees, including double lifts, 20c. per cubic yard; plugs where levees cross old channel, 32c. per cubic yard; sodding, $500 per mile. The cost of the necessary right-of-way is estimated at about $1,250,000.

Construction work will be supervised by Myers, Noyes & Forrest, engineers for the levee district, associated with the Morgan Engineering Company, Dayton, Ohio.

Musconetcong Tunnel Bores Meet

After 21 months of steady work the two headings of the Musconetcong tunnel of the Lehigh Valley Railroad met on June 19. The double track tunnel is 4,895 ft. long and will cost about $5,000,000. Articles describing the methods used on this project appeared in *Engineering News-Record* of Dec. 22, 1927, p. 988, and Dec. 29, 1927, p. 1036.

Chicago Opens Incinerator

The new incinerating plant to dispose of garbage and refuse from the north and northwest districts of Chicago was opened on June 18. It has a capacity of 600 tons daily, and although there was objection from the neighborhood, it is expected that with complete combustion and three 150-ft. smokestacks there will be little trouble from odor or dust. The plant, on Goose Island, in the north branch of the Chicago River, near Division St., was designed and built under the direction of Loran D. Gayton, city engineer. Its cost is put at about $600,000.

Approval of 38-Mile Extension Makes New Trunk Line Possible

Will Give Through Route From Middle West to Baltimore—Avoids Pittsburgh Congestion

CONSTRUCTION of a 38-mile extension to the Pittsburgh & West Virginia Railway from Cochran's Mill to Connellsville, Pa., was authorized by the Interstate Commerce Commission by a five to four vote in a decision made public June 21.

The new extension will provide a permanent connection between the lines of the Pittsburgh & West Virginia and the Western Maryland. As the Pittsburgh & West Virginia connects on the west with the Wheeling & Lake Erie, the extension will make possible a direct route from the Middle West to the port of Baltimore. Objections to the new connection were filed by the Pennsylvania Railroad, the New York, Chicago & St. Louis Railroad, the Baltimore & Ohio Railroad and the Wheeling & Lake Erie Railway, but these were overruled by the commission.

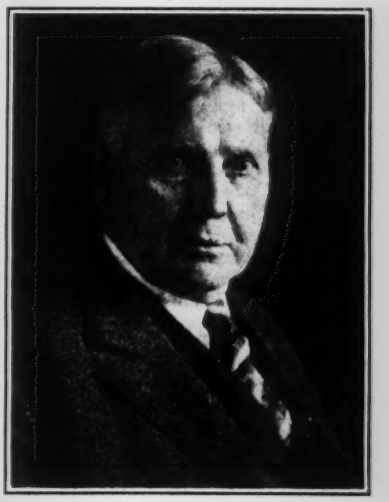
The two strongest arguments in favor of the new line, according to the Interstate Commerce Commission, are, first, that it will open a new route through the Pittsburgh district which will avoid the yards and junction points where congestion is now likely to occur, and second, that it will provide a permanent connection between the Pittsburgh & West Virginia and the Western Maryland, so that they may, in combination with the Wheeling & Lake Erie and possibly the Wabash, furnish a new and independent through route from the steel-producing territory, Lake Erie and points beyond, to the port of Baltimore.

The opposition to the line was based upon the proposed cost estimate of $12,800,000. The opposing railroads contended that this estimate would be exceeded in the construction, as the 38-mile route traverses a very difficult and hilly territory. The commission, however, held that this objection was immaterial, as none of the dissenting railroads would be financially affected by an error in the cost estimate.

The four dissenting commissioners wrote an opinion in which they stated that it had not been shown that a new and independent through route was either necessary or desirable in the public interest. It was pointed out that neither the interests of Baltimore nor of the Middle West, the two parties which were supposed to be benefited, were represented in the proceedings or had declared any interest in them.

Retirement Ends Long Service on the Mississippi River

The retirement of Brigadier-Gen. Charles L. Potter from active service in the Corps of Engineers under the retirement regulations of the army, noted in our news pages of last week, removes from active participation in the Mississippi River flood-control work one of the most able and independent engineers connected therewith. Familiarity with the river over a period of 30 years gave him an unusually large fund of experience upon which to draw in deciding the many problems which came to him in



Brig. Gen. Charles L. Potter

recent years during his term as head of the Mississippi River Commission.

General Potter's career on the Mississippi began in December, 1899, when, as a young second lieutenant, he reported to Memphis from duty in the Philippines to take charge of the Third Mississippi River Commission District. His work there was the same as now handled by that district—namely, river improvement and flood control from the mouth of the White River to Vicksburg, also temporary charge of the Vicksburg

(*Continued on p. 1020*)

Tennessee Court Upholds License Law for Engineers

The Supreme Court of Tennessee has rendered a decision upholding the provision of the state law of 1921, which requires all engineers and architects to pass an examination before a state board. The board consists of three engineers and three architects appointed by the Governor. The present test case was brought by the Standard Engineering Company, of Nashville.

Good Progress on Dam Inspection in Washington

Inspection of all important dams in the State of Washington was undertaken soon after the St. Francis failure. Out of 44 dams to be examined, 36 have been visited and reports on most of these have been filed. Thus far no serious weaknesses have been discovered. In some instances sources of possible deterioration have been pointed out and suggestions made for more systematic control and inspection than has been given heretofore.

The inspection covers all dams, private, municipal and federal, and is being made by R. K. Tiffany, state supervisor of hydraulics; C. E. Crownover, Yakima, and Lars Langloe, Olympia. The inspection of government dams on the Yakima and Okanogan projects is to be made jointly with engineers representing the federal government.

Queens Engineers Indicted for Sewer Fraud

Indictments against Maurice E. Connolly, former president, borough of Queens, New York City; John M. Phillips, alleged head of a sewer ring; Clifford B. Moore, former consulting engineer of Queens; and Frederick B. Seeley, engineer in charge of design in the Queens sewer bureau, were returned on June 22 by the Extraordinary Grand Jury which has been investigating the Queens sewer situation, by order of Governor Smith, since May 8.

Connolly, Phillips and Seeley are charged with having conspired to defraud the city of New York, with having conspired to commit acts for the obstruction of the due administration of the laws governing the award of contracts, while Connolly and Seeley are charged with having done all they possibly could to further the monopoly alleged to have been held by Phillips for Lock Joint pipe. Mr. Moore is named in the other indictment, which charges that he verified a false income tax return for 1926 under the New York state income tax law, and reported a net income of $6,870, whereas he had "an income of upward of $60,000" for that period. The Grand Jury has taken a recess until July 16. July 3 has been set as the date on which attorneys for the defendants must plead, file motions or enter demurrers.

The indictment states that the specifications for precast pipe were unlawfully and fraudulently framed so "as to tend to preclude in effect the use of any but a precast pipe manufactured or sold by the Lock Joint Pipe Company, or by the agents or licensees of said Lock Joint Pipe Company." John M. Phillips had the sole right of use of the patents and forms of the Lock Joint Pipe Company in the borough of Queens. The indictment charges that Mr. Seeley included in the specifications such unreasonable requirements governing the method of construction of monolithic sewers that contractors could not submit bids for the construction of monolithic sewers lower than bids for the construction of sewers with precast pipe. It was further stated that Mr. Connolly rejected bids when the lowest bidder was not favored by Mr. Phillips, "to the end that it might become understood by all bidders that precast pipe should be purchased by them from said John M. Phillips." Finally the indictment charges that in the construction of public sewage-disposal plants in the borough of Queens only screening apparatus and equipment manufactured by the Sanitation Corporation was permitted.

Miller Water-Power Act Upheld in Test Case Appeal

The extended litigation over the constitutionality of the so-called Miller water-power law of New York has been closed by a decision of the New York State Court of Appeals upholding the provisions of the law in the case of the Niagara, Lockport & Ontario Power Company, which sought to acquire a minor development of the Horton interests on the Salmon River. This was regarded as a test case, and action upon a number of similar applications, held up by the Public Service Commission pending the final decision, will now be taken.

The provision of the Miller law which was challenged as unconstitutional provided that a company developing the major part of a specific water-power site might, as a matter of public convenience and necessity, condemn the property of another power company using a minor portion of that site, provided fair payment was made. The law was passed in 1921 as a means of utilizing to greater advantage the water-power possibilities of the state in order that the greatest number might obtain the greatest benefit from the available natural hydro-electric sites. The present case has been before the courts of the state for four years.

Floor Failure in Chicago Building

Failure of floors and interior framing of the old five-story building of the Chicago Club which occurred on June 17 is under investigation. This building, 80x100 ft., was of steel frame construction with tile floors and heavy masonry walls. An addition has just been completed and occupied, and the old structure vacated for alterations necessary to connect the two buildings and make a unit structure. The portion which failed was to remain unaltered, so that the interior work is not thought to have had any effect upon it. On Sunday morning, with little warning, a large portion of the fourth floor dropped and carried down the other floors in succession. The roof and the masonry walls remained intact. It is now intended to rebuild the interior entirely instead of making alterations. The architects are Granger & Bollenbacher, and the contractor is the E. L. Scheidenhelm Company.

San Francisco Engineers Discuss St. Francis Dam Failure

The largest meeting in the history of the San Francisco Section, American Society of Civil Engineers, was held on June 19, the topic of the evening being "Technical Aspects of the Failure of the St. Francis Dam."

The program included the following: "A General Description of the Dam and Its Collapse," by Frederick H. Power, consulting engineer; "Devastation and Rehabilitation in the Santa Clara Valley," by Nathan A. Bowers, Pacific Coast editor, *Engineering News-Record*; "Geological Conditions at the Dam Site," by George D. Louderback, professor of geology, University of California; "State and Federal Control Over California Dams," by Edward Hyatt, state engineer; "Theories on the Causes and Sequence of Failure," by Charles H. Lee, consulting engineer.

In the discussions that followed this comprehensive review, the theories that are now employed in the design of dams were analyzed critically. Alleged disadvantages of curving gravity section dams were discussed and uplift and ratio of base width to height under various conditions were presented in an analytical light. Differences of opinion were brought out in a vigorous way with reference to the immediate cause of failure and the sequence of the break-up. Among those who presented discussion were C. E. Grunsky, Arthur P. Davis, George L. Dillman and Lars Jorgensen.

Gen. Potter's Mississippi Record

(*Continued from p.* 1019)

and Little Rock engineering department districts for short periods.

From 1903 until 1910 he was on other duty, returning to the river work in August of the latter year to take charge of the St. Louis district office. This work included river improvement between the mouth of the Ohio and the mouth of the Missouri, snagging from the mouth of the Missouri to New Orleans, and charge of channel lights over the same reach of the river. During this period he served as secretary of the Mississippi River Commission and as division engineer of the Western Division (rivers and harbors). As secretary he had charge of the dredging operations under the commission, and as division engineer he was responsible for the engineering districts at St. Paul, Rock Island, Kansas City, St. Louis, Little Rock and Vicksburg, embracing the entire Mississippi River above Cairo, all its western tributaries and all its eastern tributaries except the Illinois and Ohio. In August, 1912, he was relieved of these duties and transferred to St. Paul as district engineer in charge of work on the Mississippi above St. Paul and the tributaries. This position he held until July, 1915.

In 1920 Colonel Potter returned to St. Louis as president of the Mississippi River Commission, as division engineer of the Western Division and superintendent of the Fifteenth Lighthouse

District. Since that time he has served continually as president of the commission. In those eight years the commission had to contend with the two worst floods on record, that of 1922 and 1927. The first came before the levees on the main river had been raised to the grades established by the commission, and consequently it was difficult to determine how well levees built to that grade would hold the flood, but when the 1927 flood came its crest reached heights which indicated that the commission's grades would have to be raised to unprecedented heights if the commission was to continue to hold to the "levees only" policy.

Following the 1927 flood the Mississippi River Commission, under Colonel Potter's direction, began the preparation of a revised plan of flood control based upon its experience in that flood, for submission to Congress. It abandoned the levees-only principle and adopted floodways and spillways as auxiliaries to levees. The plan did not meet with the approval of the administration and an attempt was made to suppress the report; however, when Congress took up the flood-control subject it published the report. Later, in the flood-control act, as finally passed, it took cognizance of the commission's plan by making provision for a board of review to weigh the plans of the commission and of the Chief of Engineers, and adopt whatever features of each it thought best.

Congress also attempted to insure that Colonel Potter be a member of that board by making special provision in the bill for his being continued in active service as president of the commission and so a member of the board, Colonel Potter having reached the retirement age in January. Despite this provision, the President on June 11 appointed Col. Thomas H. Jackson president of the commission. Simultaneously Colonel Potter was promoted to the rank of brigadier general as of May 15, the date of the passage of the flood-control act, the act having provided that rank for the president of the Mississippi River Commission.

From the date the flood-control act was passed until the date of General Jackson's appointment, General Potter was kept in ignorance as to whether he was to continue as president of the commission and a member of the board of review. On June 11 a newspaper reporter brought him the news that his successor had been appointed. This casual and unofficial report was the first notice he had of the ending of his 46 years of service in the army and eight years as president of the commission.

Dotsero Cutoff Hearing Soon

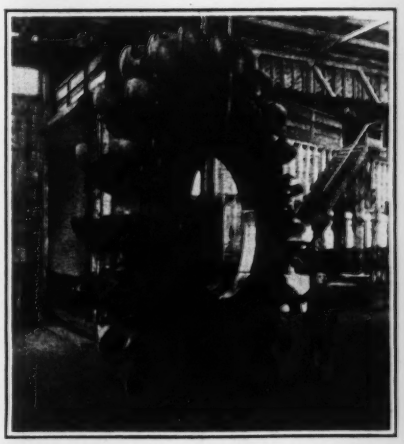
The Interstate Commerce Commission has notified officials of the Denver & Salt Lake Western Railroad that it is ready to conduct a hearing on the application to build the Dotsero cutoff, the projected line which will connect the Moffat tunnel with the Denver & Rio Grande Western at Dotsero. Construction of 42 miles of new track will save 173 miles in the present rail distance from Denver to Salt Lake City by way of the Denver & Rio Grande.

The plan for the cutoff was first proposed about 3½ years ago, at which time a protest was made by officials of the projected Salt Lake & Denver Railroad. It is expected that the hearing will bring out these objections.

Ask Rehearing on Van Sweringen Merger Plan

A petition requesting the reopening of the case in which the Interstate Commerce Commission recently authorized the Chesapeake & Ohio Railway to acquire control of the Pere Marquette Railway but denied the application for authority to acquire the Erie, has been requested by seven short-line railways which were parties to the proceedings and which connect with one or the other of the roads involved in the application. The complaint states: "The commission's decision of May 8, 1928, grants the strong Chesapeake & Ohio the right to acquire the strong Pere Marquette, but denies the strong Chesapeake & Ohio the right to acquire the weak Erie and imposes no condition which requires any of the intervening or other short lines to be acquired by the applicant. The sanction of the combination of roads already strong and probably already earners of excess incomes, while denying or not requiring the inclusion of weak carriers, is entirely contrary to the spirit and purpose of Section 5 of the interstate commerce act, disregards and flouts the intention of Congress and contradicts the commission's own representation to the committees of Congress when Section 5 was under consideration."

RUNNER DESIGNED FOR 2,200-FT. HEAD



Two such Pelton waterwheel runners on a double-overhung unit will develop 56,000 hp. in the Big Creek 2A plant of the Southern California Edison Company. The runner illustrated is 16.5 ft. in diameter and weighs 25 tons. A feature of the wheel is the demountable type runner; ring and buckets can be replaced in 24 hours.

McGraw-Hill and A. W. Shaw Companies Merge

A consolidation affecting twenty engineering and industrial papers, and *Magazine of Business, System* and *Industrial Distributor and Salesman* has been brought about by the merger of the McGraw-Hill Publishing Company, Inc., of New York and the A. W. Shaw Company of Chicago. The two companies have had a close relationship since last fall, when they jointly formed the McGraw-Shaw Company, which publishes *Factory and Industrial Management* and *Industrial Engineering*.

Mr. A. W. Shaw will continue as chairman of the board and Mr. James H. McGraw will become president of the A. W. Shaw Company, which will be known as the "A. W. Shaw Company, a division of the McGraw-Hill Publishing Company, Inc." The McGraw-Shaw Company will also be operated as a division of the McGraw-Hill Publishing Company. Mr. Shaw will also become a director of the McGraw-Hill Publishing Company, Inc., and will continue as president of the McGraw-Shaw Company. Mr. Wheeler Sammons will become a director and member of the executive committee of the McGraw-Hill Publishing Company and senior vice-president and general manager of the A. W. Shaw division of the business.

Two reasons for the merger are stressed by the officers of the merging companies. The magazines of the two organizations are complementary in character. The Shaw papers cover business broadly, giving the business man an understanding of what is going on in all branches of trade, industry and finance. Their service is extensive in character. The McGraw-Hill service, on the other hand, is intensive. Its magazines give a highly specialized service to given major industries and to related industrial groups. Thus the consolidated companies serve the business man in both his general and special business interests. The second reason is the very evident economy and increased effectiveness of consolidated operation, enabling a superior service to be rendered to American business.

Alcove Dam Bids Called For

Bids will be received July 9 for the construction of the $1,000,000 Alcove dam at Hannacroix Creek, the second project in Albany's new $12,000,000 water-supply system. The dam will be about 2,100 ft. long and 85 ft. high.

A diversion tunnel will help connect this reservoir with the reservoir to be provided several miles to the west through the building of the Basic Creek dam, preliminary work on which is now under way. Specifications for the diversion tunnel are now being prepared.

The principal items as called for in the Alcove dam specifications are the excavation of approximately 57,000 cu.yd. of earth, the building of a consolidated embankment of approximately 320,000 cu.yd. and the placing of 28,400 cu.yd. of concrete.

Washington Notes

By Paul Wooton
Washington Correspondent

Contractors Propose Registration of Bidders—Levee Contracts to Be Let—Water-Power Development

A standard registration act for the handling of records in connection with public construction work is being drafted by the Associated General Contractors and will be submitted to the legislatures of the various states. Under the terms of the proposed bill all persons bidding on state work would be registered. It would be the duty of the board administering the act to investigate the previous work done by the bidder. In the case of default the name of the contractor would be dropped from the registration list for a period of two years. In connection with the proposed legislation the General Contractors will recommend that the members of the registration board be chosen from the ranks of experienced engineers and architects of such standing in the community as to be above political influence. The proposed legislation is an effort to eliminate the irresponsible and unscrupulous contractors from those who may bid on public works.

To Let Levee Contracts

The awarding of contracts for levee work on the Mississippi River will begin about the middle of July, at which time the necessary period for advertisement will have passed. More is involved than the $8,400,000 which has been allocated for levee work during the present session. Where desirable, contracts for long periods are being sought. On this work preference will be given local contractors because of their familiarity with the work.

Water-Power Developments

The Federal Power Commission on June 14 issued a preliminary permit to Hugh L. Cooper for his project in Z Canyon on the Clark Fork of the Columbia River in Washington. Some 200,000 hp. of primary power will be made available by this development. The power is to be used for commercial and public utility purposes.

A final license has been issued to the Savannah River Power Company covering its development on the Savannah River above Augusta, Ga. It is planned to install 120,000 hp.

The Alabama Power Company has requested the termination of its license covering proposed Plants No. 1, No. 2 and No. 3, on the Talapoosa River. It is understood that the decision to abandon these plants above the Cherokee Bluffs development, which it had been authorized to construct, was influenced by the increasing obstacles being placed in the path of water-power development. The state tax on water power was an important feature. The accounting regulations of the Federal Power Commission constituted another barrier. These and other difficulties are not encountered to the same extent in the development of power by steam. For that reason the Alabama company is turning more and more to the use of steam.

Random Lines

Swelling the List

An educator, so called, comes out with the assertion that the world's great need is Art Engineers! Why not "art woodchoppers" or "art soapmakers"?

But the need is already being filled, it seems. The National Small Sculpture Committee requests the honor of our presence at the

Fourth Annual Exhibition of
Small Sculptures in White Soap
For the Procter & Gamble Prizes
At the Anderson Galleries
489 Sixth Avenue, New York
From June Sixth to June Thirtieth,
Inclusive
Nine to Five, Weekdays
Nine to Twelve, Saturdays
Closed Sundays

We take it that later on there will be a second head, this one in yellow soap, followed ultimately by the finals, with white soap, yellow soap and tar soap in the running.

Do we need Art Engineers if the world's craving for esthetics is thus satisfied?

A New Method of Piledriving

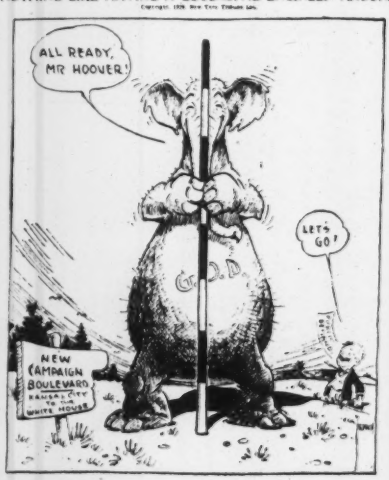
Extract from specifications for piledriving at Long Beach:

"Piles may be driven by a drop hammer weighing . . . or by means of a water jet, or by a combination of water jet and *steam laundry*." (The italics are ours.)

West Coast Concrete Practice

Through the work of the chemist in our department they got such a mixture of sand, gravel and cement that it is the best concrete in any structure in San Francisco. It stands 2,900 lb. per sq.in. —*From an address by a West Coast city engineer.*

NOTHING LIKE HAVING A GOOD CIVIL ENGINEER AROUND



Brief News

Immediate Construction of an all-weather trans-Canadian highway to meet changed conditions of transportation and provide intercommunication between provinces was urged in a resolution adopted at the 28th annual convention of the Union of Canadian Municipalities, held in Winnipeg recently. Both the dominion and provincial governments will be memorialized as to the necessity for such a road. By an all-weather road, the resolutions committee meant an asphalt highway. It was estimated that $50,000,000 would be required to carry out the work. At present there is no highway in Canada connecting the eastern with the western provinces.

Twenty-five Sanitary Engineers and other technical assistants in the United States Public Health Service attended a course of instruction held recently at the Stream Pollution Investigations Station at Cincinnati, Ohio. The course extended over nearly two weeks. A variety of topics connected with water supply, stream pollution and other work of the public health engineers was taken up, including a considerable amount of laboratory work, both chemical and bacterial.

A 200-Ft. Timber Section of the Pasco-Kennewick highway bridge over the Columbia River in Washington was recently carried away by floods in the river.

A Concrete Caisson in the middle of the Tennessee River at Knoxville, Tenn., which was to hold one of the new piers of the new state highway bridge toppled over and fell into the river the afternoon of June 21. Ample warning of settlement was given, so no injuries resulted.

Stand-By Steam Apparatus for operating the Hudson River bridge at Albany was called upon to function for the first time in eighteen years when one of the master gears of the electrically operated turntable broke on June 10.

Contract for the Steel Tubes comprising the underwater section of the Detroit-Windsor tunnel has been secured by the Canadian Bridge Company, Walkerville, Ontario.

The Delmar Viaduct over the Wabash Railroad tracks, connecting St. Louis and University City, Mo., was opened at a celebration attended by more than 8,000 people. The cost of the viaduct was $540,000.

Disapproval of the Plan recently advanced for decking over the subway in the old Erie Canal in Rochester, N. Y., in order to make an automobile speedway has been voiced by the traffic committee of the Rochester Engineering Society. The committee reports that the plan is visionary, unnecessary and financially impossible at the present time.

Engineering Societies

Calendar

Annual Meetings

AMERICAN SOCIETY OF CIVIL ENGINEERS: Annual Convention, Buffalo, N. Y., July 18-20.

NEW ENGLAND WATER WORKS ASSOCIATION, Boston, Mass.: Annual Convention, Montreal, Canada, Sept. 18-21.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, St. Louis, Mo.: Annual Convention, Detroit, Mich., Oct. 22-28.

THE ENGINEERS CLUB OF MINNEAPOLIS has elected as officers for 1928-29: President, Charles E. Doell, secretary, Board of Park Commissioners; vice-president, James A. Colvin; secretary (re-elected), Arthur F. Mellen.

THE COLORADO SECTION, American Society of Civil Engineers, held its annual convention at Colorado Springs, June 16-17. The engineers visited the Big Tooth dam construction now under way. W. W. Curtis, of Colorado Springs, was elected president; Ivan Houk, Denver, vice-president, and N. W. Funk, Western representative of the Kansas City Structural Steel Company, with office in the First National Bank Building, Denver, secretary-treasurer.

THE ASSOCIATION OF HIGHWAY OFFICIALS will hold its next annual meeting in Chicago, Nov. 12-15. The procedure at this meeting will provide for group meetings on the following subjects: administration, construction, design, maintenance, equipment, finance and traffic control. No minutes will be taken, and those in attendance will be urged to discuss controverted questions with the utmost frankness.

THE AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS has brought to a close the annual meeting at Washington, D. C. During the meeting an address was given by William Butterworth, president of the Chamber of Commerce of the United States. The delegates were informally greeted by Secretary Hoover, who complimented them upon the work they were doing in their special field.

Personal Notes

CHARLES KENDALL has been appointed county engineer for Anderson County, Texas, succeeding the late E. W. Davis.

W. J. BURTON has been appointed assistant to the chief engineer of the Missouri Pacific Railroad, with headquarters in St. Louis.

CAMERON J. SMITH, formerly resident engineer for Monroe County, Florida, on the construction of the boulevard at Key West and who recently served with the Lighthouse Service at Key West, has been appointed assistant engineer, U. S. Engineer Service, at Nashville, Tenn. Mr. Smith is a graduate of Cornell University, class of 1922.

FRANK S. KRUG and FRANK S. KRUG, JR., announce the formation of a new firm, Krug & Krug, consulting engineers, specializing in engineering problems pertaining to the construction of highways, public works and buildings, with offices in Cincinnati. Frank S. Krug was for twelve years city engineer of Cincinnati, and Frank S. Krug, Jr., was chief engineer of construction of the Ohio State Highway Department from 1921 to 1923 and for the past five years engineer for the Cincinnati Quarries Company and the Byrnes-Conway Company.

NEIL WELDEN has left the bridge department of the Chicago, Rock Island & Pacific Railway Company, Chicago, where he had been employed as designer and draftsman for the last two years, to take a position as designer with the Cleveland Union Terminals Company, Cleveland, Ohio.

ROBERT P. MASON, after nearly two years with the Water Resources Service of Pennsylvania as assistant engineer, is now keeping time and cost records for A. W. Byrne & Son, general contractors, of Hartford, Conn., on the construction of 5 miles of sewer line. Mr. Mason is a graduate of Cornell University, class of 1925, and received his Master's degree in 1926.

H. B. BIGELOW has been placed in charge of the new branch office opened in Memphis, Tenn., of the W. A. Fuller Company, engineers.

THOMAS C. HIGGINS, formerly with the Pittsburgh branch of the Byllesby Engineering & Management Corporation, is now located at the West Point Military Academy, where he is superintendent of construction.

R. N. MATTHEWS, of Savannah, Ga., formerly superintendent of the Steel Products Company, of that city, for seven years and later with the Ozark Engineering Company, of Joplin, Mo., is now with the J. B. Klein Iron & Foundry Company, of Oklahoma City, Okla., as superintendent of its structural plant.

Lieut. Col. MARK BROOKE, Corps of Engineers, U. S. Army, at present serving as district engineer at Jacksonville, Fla., has been selected to be division engineer of the Gulf division, with headquarters at New Orleans.

WILLIAM S. MORTON, who for the past two years has been engineer in charge of grade separation in Chicago for the Pennsylvania Railroad, has resigned from Pennsylvania service, and has returned to his old home at Beaufort, N. C., for an extended vacation. Before entering the service of the Pennsylvania system, Mr. Morton was assistant engineer on track elevation in Chicago for the Chicago & Western Indiana Railroad, and prior to that was resident engineer for the Spruce Falls Company, Ltd., in charge of construction of a concrete sulphite mill in northern Ontario. His future plans are indefinite.

Major ROBERT S. THOMAS, of the U. S. Engineers, who has just completed a four-year detail in Washington, has been ordered to Buffalo to take charge of the U. S. Engineers' Office there.

Obituary

FRANK NEHER, a pioneer railroad builder of the Central and Western states and formerly an assistant chief engineer for the Missouri Pacific Railroad, died in Washington, Mo., on June 12. He was 71 years old. Mr. Neher, who retired in 1918, was a member of the American Society of Civil Engineers. He was with the Missouri Pacific for twelve years and for ten years prior to that was connected with the Illinois Central's engineering department. With the Missouri Pacific he constructed the freight terminals at Dupo, Ill.

JOSEPH K. CHOATE, consulting engineer, president of the Morris County Traction Company and until recently vice-president of the J. G. White Management Corporation, died on June 19 in San Francisco of pneumonia. He was 74 years of age. Mr. Choate had been a civil engineer for the New York City Department of Public Works, chief assistant engineer in the construction of the Erie Railroad, superintendent of the Union Pacific Railway and then, for more than nineteen years, a consultant on railway problems. He recently acted as spokesman for the Equitable Coach Corporation in its efforts to obtain bus franchises in New York City. At the time of his death Mr. Choate was in California to examine some properties for the Southern Pacific Railway.

RODERICK BREWDER, well-known Canadian contractor, died at his home in Ottawa on June 19 at the age of 82. Mr. Brewder had been in the contracting business for more than 50 years. Among the projects with which he has been associated may be mentioned the Canada Atlantic Railway, the Carillon dam, docks at Fort Hope and Cobourg, and two large bridges in Ottawa.

LEONARD A. KELLY, assistant city engineer of Rochester, N. Y., died on June 20, aged 50 years. Mr. Kelly was born in Philadelphia and had been engaged in city work in Rochester for 25 years.

A. H. DANFORTH, structural engineer, builder of the original steel plant of the Colorado Fuel & Iron Company, died at Canon City, Colo., on June 8. He was 76 years old.

Construction Equipment and Materials

A Section Devoted to What the Manufacturer Is Doing for the Engineer and Contractor

Mixer Merger Announced

The merger of the Construction Machinery Company, Waterloo, Iowa, and the Marsh-Capron Company, Chicago, has been announced by H. B. Lichty, president of the Construction Machinery Company. Both lines of equipment are to be continued as in the past and the sales and service organizations of the two old companies will remain intact. Mr. Lichty states that the merger was effected for the purpose of bringing about the economies of common management rather than for the elimination of either organization. The new arrangement will make possible the manufacture of a complete line of tilting and non-tilting equipment. It is further stated that the new merger is now in effect and that all communications should be addressed to the old companies as in the past.

Contractors and Equipment Men Approve Strong Credit Policy

The irresponsible contractor and the responsibility of the machinery interests in supporting him by furnishing equipment at unreasonably favorable terms, to the detriment of the manufacturing and construction industries as well as to public interests, was the subject of discussion at a special meeting of the Associated General Contractors of America and the equipment manufacturers and distributors of the Chicago district, held in Chicago on June 20 and 21. This meeting was one of a series arranged by the A.G.C. to be held at different parts of the country in a campaign to promote standardization of credit and of sales policies in regard to construction equipment and machinery. A large attendance included representatives of 33 manufacturers and six distributors, while the A.G.C. was represented by six of its officers, including D. A. Garber, general manager, and S. M. Williams, manager of the engineering construction division.

In an informal opening address by Mr. Williams, the situation was explained and reference made to a resolution adopted by the A.G.C. at a meeting in May. That resolution pointed out that a wide practice of selling equipment on a small initial payment, with the balance extending over a long period, has tended to develop many irresponsible construction concerns. The association not only urged the establishment of reasonable standard credit policies by the equipment interests, but urged members of the A.G.C. to submit to such policies and to favor those manufacturers and distributors who maintain these policies. Terms suggested at the meeting were a substantial payment at the time of purchase (30 per cent was suggested as preferable) and the balance in not more than one year.

Discussion supported the principles of the resolution, but there were references to certain difficulties to be encountered, as in the case of competition. On the other hand, numerous examples of extended credits and their results were cited. A resolution was passed indorsing the A.G.C. resolution and recommending a continuation of conferences along the lines suggested. Following the general meeting of two sessions on June 20 there were meetings of represetatives of groups of manufacturers of power shovels, concrete mixers and other equipment. Further meetings are to be held by similar groups of manufacturers.

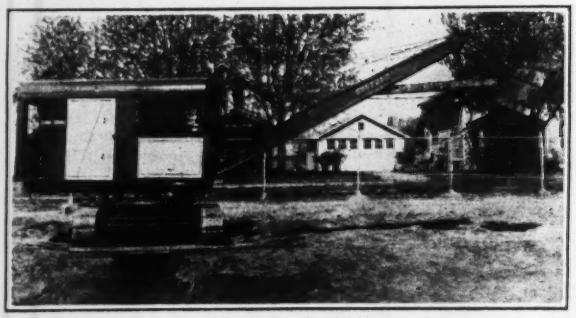
New Developments

Jawed Clutch Replaces Sliding Gear in New ½-Yd. Shovel

A new ½-yd. shovel, model B-2, has recently been introduced by the Speeder Machinery Corporation, Cedar Rapids, Iowa, to supersede its model B-1. The sliding gear used in the model B-1, in making the change from traction to swing, has been made obsolete by the introduction of a reversible jawed clutch assembly. The new design is said to retain all the desirable features of the sliding gear and has the added advantages of positive mesh of the gears at all times and of making all vertical shafts removable.

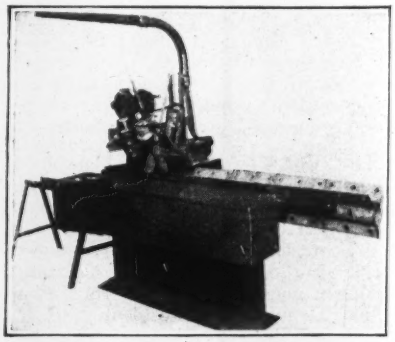
Electric lights and starter are standard equipment on the new model. There are two flood lights on the top of the cab for night work or travel, a dome light in the top of the cab which illuminates the upper mechanism, and a spotlight to be used for a trouble light. The starter button is situated on the floor boards, so that the operator can shut off his motor while waiting for trucks and start immediately by merely moving his foot to the starter button.

A Hercules Model OX engine is used in Place of the Model O, which powered the B-1 shovel. Other improvements on the new model are double tread sprockets that are heavier in weight and a large turntable that is likewise greatly increased in weight.



Ductile Welds Produced by New Electric Process

Following several years of research, the engineers of the Lincoln Electric Company, Cleveland, have devised a process of electric welding by means of which a strong magnetic field is superimposed on the arc flame of the welder, which, it is claimed, tends to hold the arc flame in a straight line and to give it a gyratory motion of great velocity. This process has been termed the "electronic tornado." A series of tests made on welds produced by this process showed that the welds had as great ductility and strength as did equivalent sections of mild steel. The welds were sawed from the plate, and the resultant bars twisted through 1,080 deg., or three complete revolutions, without showing any indication of failure.



FRONT AND REAR VIEWS OF NEW ELECTRIC ARC-WELDER

The first application of this process to commercial arc-welding has been made by Lee C. Moore & Company, Inc., Pittsburgh, Pa., manufacturer of

oil field derricks. In the accompanying illustration the machine is shown with a tubular derrick corner clamp in place for welding. It is claimed that the machine places welds at the rate of over 40 ft. per hour for each welding head. It is further stated that no filler rod is used, since the arc fuses the various plates together.

From the accompanying illustration it may be seen that there are two of the new type welding heads with their electrode holders crossing each other at a sharp angle. The manufacturer states that with an uncontrolled arc (that is, one in which no extra magnetic field was used) it would be impossible to operate two flames at such close proximity, since one would continually blow the other out. With the new head, however, it is stated that they work smoothly and without conflicting.

Asphalt Emulsion for Curing Concrete

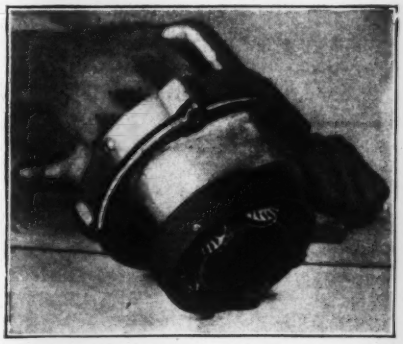
An asphalt emulsion manufactured specifically for the purpose of curing concrete has been introduced by the Barber Asphalt Company, Philadelphia, Pa., under the name of "Curcrete." It is applied to freshly finished concrete in the form of a fine spray, and the adherent continuous film of asphalt left by the emulsion prevents the evaporation of water from the concrete mixture. It is suitable not only for use on highways but for curing concrete foundations, sidewalks, floors, platforms and bridge decks, and, in fact, any flat-slab surface concrete construction.

Because it maintains conditions suitable for hydration for a longer period of time than other methods, it is claimed to accelerate curing. This acceleration is caused by its absorption of solar heat and is not a result of any chemical reaction, since the emulsion is chemically inert.

The Curcrete is applied by a sprayer built by the Barber Asphalt Company, Buffalo, N. Y. The machine consists of a 40-gal. galvanized iron tank and an air compressor unit driven by a single-cylinder gasoline engine, all of which are mounted on two iron wheels, making the machine readily portable. The weight of the machine loaded is approximately 300 lb. A suitable spray nozzle is mounted on a length of ½-in. pipe connected to the pressure tank by means of a flexible hose 50 ft. in length. It is claimed that Curcrete can easily be applied at the rate of 150 to 200 sq.yd. per hour.

New High-Speed Air-Operated Concrete Surfacer

A new lightweight concrete surfacer has recently been developed by the Tousley Tool Company, Cleveland, Ohio, and placed on the market as its No. 7-A model. The new surfacer weighs 9 lb., and requires 30 cu.ft. of free air per minute. It is claimed to be exceedingly easy to handle from scaffolding or from ladders. The machine has a speed of 3,600 r.p.m., and such a high cutting speed is claimed to materially increase the amount of surface that can be finished within a



given time. The machine is closely coupled, the operator's hands being close to the work, which insures positive control at all times. A special cutter head is also available for use in smoothing rough concrete.

Manufacturers and Trade Associations

Calendar

Annual Meetings

TRACK SUPPLY ASSOCIATION, Chicago; annual exhibition and convention, Detroit, Sept. 18-20, 1928.

New Publications

Concrete Curing—EVERLASTING PAINT & SALES COMPANY, Los Angeles, Calif., has published a booklet entitled "Curing Concrete Without Water or Dirt by the Hunt Process." The bulletin illustrates and describes the method of applying a coating of the company's asphaltic preparation on concrete surfaces immediately after the concrete has been poured. The covering is claimed to keep all moisture within the concrete mass from evaporating and thus to insure perfect curing. The bulletin describes some tests recently made by the Los Angeles County Road Department on some pavements cured by the Hunt process.

Locomotive Cranes—ORTON CRANE & SHOVEL COMPANY, Chicago, Ill., features the advantages resulting from the application of heavy-duty gasoline engines to locomotive cranes in its recent bulletin No. 56. The mechanical features of the company's locomotive cranes are illustrated and described in detail. Tables of clearance dimensions for both four-wheel and eight-wheel cranes are included as well as a table of normal lifting capacities for standard-gage locomotive cranes.

Electric Motors—THE LOUIS ALLIS CO., Milwaukee, has published four new catalogs describing its various types of electric motors. Bulletin 502-A is devoted to the company's inverted rotary converters. Bulletin 504 describes slip-ring motors. Bulletin 505 describes squirrel-cage motors, and Bulletin 506 describes single-phase, squirrel-cage condenser motors. In each catalog the motor is shown unassembled, each part being illustrated and described.

Crusher Screens—THE LUDLOW-SAYLOR WIRE CO., St. Louis, has published a booklet entitled "Controlling Crusher Wastes With Woven Screens." The book contains a discussion of screen openings, including a comparison of square with the larger round openings required to make the same separation. Illustrations are given to show why the square hole screen has more holes and greater capacity than a round hole screen of the same strength. Many tables giving characteristics of the company's screens are included. The data are amplified with photographs and applications of the principles of screening with woven square-mesh screens.

Street Lighting Equipment—WESTINGHOUSE ELECTRIC & MFG. COMPANY, East Pittsburgh, Pa., devotes a new catalog, 218-A, to its overhead street-lighting equipment. In it are given descriptions, tabular dimensions and prices of street-lighting units and all necessary accessories manufactured by the company. The catalog is devoted strictly to utilitarian street-lighting systems as distinguished from the ornamental systems described in another of the company's catalogs. The latter catalog devotes 60 of its 128 pages to pictures and dimensioned line drawings of lighting standards. In both catalogs all new equipment and improvements on former designs are given.

Rail Steel Products—BUFFALO STEEL COMPANY, Tonawanda, N. Y., has published a book on its various rail steel products. Information is given on its reinforcing steel on angle, tee, flat, channel, and special sections and on the company's steel fence posts.

Workable Concrete—CELITE PRODUCTS COMPANY, Los Angeles, Calif., has published a pamphlet entitled "Designing Concrete for Workability as Well as Strength." A discussion of workability comprises the text matter. In addition tabulated matter shows test results from several laboratories where Celite was used to obtain workability. There is also included a description of the method of testing for workability by using the penetration machine developed by Pearson and Hitchcock at the Bureau of Standards.

Crushers—TRAYLOR ENGINEERING & MANUFACTURING COMPANY, Allentown, Pa., has published bulletin No. 2100, superseding its bulletin No. 1100, describing its gyratory crusher, type T. Illustrations and descriptions of the various parts of the crusher, tables and line drawings are given. In addition, a number of charts and diagrams illustrative of crusher plant layouts are included.

Business Side of Construction

Facts and Events That Affect Cost and Volume

Seasonal Inactivity Shown by Smaller Bond Offerings

Bond offerings for each of the weeks ended June 15 and June 22 were lower than those of any other week this year, except the first week in January. The totals for these weeks were $31,760,000 and $67,289,000, respectively. Four weeks of June, 1928, show a smaller total than the same period of 1927.

The tendency toward inactivity during this season until September is not unusual and all groups of bonds have been offered in smaller volume during the last two weeks. The largest class was

RECENT BOND OFFERINGS

	Amount	Interest Rate	Yield
Public Utility:			
Lorain Telephone Co	$1,000,000	5	5
Suburban Light & Power Co	1,000,000	6	6.10
Consolidated Gas Utilities Co	8,000,000	6	6.15
Palmer Corp. of Louisiana	4,000,000	6	6.13
Newport Water Corp	1,650,000	5	5.10
United Telephone & Telegraph Co	1,000,000	5½	5½
Municipal:			
Buffalo, N. Y	$8,550,000	4-4½	4
Pittsburgh, Pa	6,356,000	4½	4
Dallas, Tex	3,575,000	4½	4.15
Milwaukee, Wis	4,275,000	4½	4.10
Miami, Fla	1,200,000	4¾	4¾
Cook Co., Ill	2,700,000	4	
Portland, Ore	1,000,000	4	4.20
Louisville, Ky	5,500,000	4½	4½
Mobile, Ala	1,500,000	4½	4.35
Maryland Road & Bridge	1,250,000	4	4
Birmingham, Ala	1,175,000	4½	4¼
Lynchburg, Va	500,000	4	4.10
Foreign:			
East Prussian Power Co	3,500,000	6	6¼
Gesdurel Sinking Fund Debenture	5,000,000	6	6
Piedmont Hydro Electric Co.	4,000,000	5½	5¼
Liepzig Trade Fair Corp	2,000,000	7	7.12
Dept. of Antioquia (Republic of Colombia)	4,350,000	7	7.29

municipals, $38,390,000, then in order were: foreign, $18,850,000; public utility, $16,650,000; miscellaneous, $11,000,000; real estate, $7,270,000; industrial, $6,900,000, and no railroad bonds.

Municipal offerings in June have exceeded both April and May, 1928, and June, 1927. The average yield of twenty represented state and city bonds as computed by the *Wall Street Journal* stood at 4.06 per cent on June 22, at 4.05 on June 15, and the average throughout January and February was 3.86 per cent.

This Week's Contracts

Heavy construction contracts, reported by *Engineering News-Record* in the week ended June 28, with some comparisons, total as follows:

(In Thousands of Dollars, 000 Omitted)

Week Ended	Public	Private	Total
June 28, 1928	**45,215**	**80,536**	**125,751**
June 19, 1928	28,738	28,743	57,481
June 28, 1927	23,322	50,344	73,666
Jan. 1 to date: 1928	665,721	1,080,265	1,745,986
1927	604,130	910,849	1,514,979

E. N.-R. Index Numbers

Cost		Volume	
June 1, 1928	**206.15**	**May, 1928**	**299**
May 1, 1928	207.00	April, 1928	316
June 1, 1927	205.55	May, 1927	299
Average, 1927	206.24	Average, 1927	263
Average, 1926	208.03	Average, 1926	228
1913	100.00	1913	100

News of Business Trends

The volume of business in the week ended June 16, as measured by check payments, although smaller than in the preceding week, is considerably larger than in the same week of 1927. Construction contracts in this same week were less in total value than those awarded in the preceding week. The current week's total is $125,751,000. Figures for both public and private lettings are given in the box elsewhere on this page.

Building costs at the end of May stood just about where they did through April, according to the American Appraisal Company's indexes. The general index for the country is 203.05, which is exactly the figure for May, 1927. The April value was 202.9. General wholesale prices were higher during the week of June 16 than they were the first week of June or a year ago.

Loans and discounts of Federal Reserve member banks were higher than in either the preceding week or the corresponding week in 1927. Stock prices averaged lower than in the preceding week, and this has been the course of the market throughout the first half of June. "The real extent of the liquidation of the Stock Exchange," says the *Guaranty Survey*, "may be judged more accurately from the volume of trading that accompanied the decline in prices than from the price recession itself. Apparently the immediate reason for the reaction was the sharp advance in money rates which carried the quotation on call loans against stock exchange collateral as high as 7 per cent, a level not equaled since 1921." The *Survey* points out that the fluctuations in the security market have not been the result of altered business conditions and do not seem likely to affect them greatly or for a long period. Bond prices reflecting higher interest rates averaged lower than in the preceding week and are slightly above the level of last year.

Unfilled orders of 256 Southern pine and West Coast mills at the end of last week amounted to 746,490,171 ft., as against 754,537,824 ft. for 257 mills in the previous week. The Southern pine mills last week's orders on the books exceeded those of the week previous by 2 per cent. On the West Coast orders are 2 per cent below those of the week before. The 444 reporting softwood mills had shipments 109 per cent and orders 106 per cent of actual production.

Factory orders on motor vehicles in May were 425,990, as compared with 410,189 in April and 404,115 in May, 1927. Production in the first five months was 5 per cent ahead of that of a year ago for passenger cars and 12 per cent under for trucks.

Favorable conditions in the steel industry are confirmed by the comparison of orders for several important products shown in the accompanying table. These orders, except in the case of steel boilers, are percentages of capacity production.

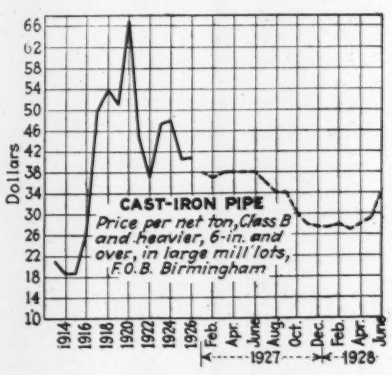
The only increase in demand for fabricated steel plate in May has been for stocks and miscellaneous purposes. The principal falling off has been for oil storage tanks and tank cars. Structural steel shipments in May were larger than those for April as well as those for May, 1927.

ORDERS, AS PERCENTAGES OF CAPACITY PRODUCTION

Fabricated steel plate	53	63	47
Fabricated structural steel	84	63	62
Steel castings	59	58	50
Steel boilers (number)	1,572	1,325	1,419

May shipments of enamel sanitary ware totaled 463,017 pieces, as compared with 406,734 in April and 376,464 in May, 1927. Shipments, new orders and unfilled orders for all such products in the first five months of this year were well above the figures for the same period in 1927. Here it might be stated that total building construction is 8 per cent ahead of that for the first five months of 1927.

Among large construction projects in Great Britain reported recently are: a £1,600,000 superpower station, Liverpool; a £100,000 addition to engineering works, Chelmsford; a £325,000 distillation plant, Bedwas; a £300,000 cement plant, Kelton; and in London, college buildings, £480,000, a £6,657,205 housing program, and a £1,000,000 hotel.

Cast-Iron Pipe Prices Up

Prices of cast-iron pipe rose in April and in May in response to active buying. The Birmingham base, $27.50 in January, $27 in March and $29 in May, is now $34 per ton. This price is $4 per ton under that of a year ago and is comparable with quotations as of August and September, 1927.